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Changing Cigarette Consumption Patterns and their Relationship to Tobacco Control Policies in a Population of Low-Intensity Smokers

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by

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DEDICATION

I would like to dedicate this accomplishment to my husband and my best friend, Srinivasa Pavan Dasika. I would not have achieved this milestone without your love, support, patience and encouragement. I also want to dedicate this dissertation to my daughter, Akshara Dasika, for being my sunshine and for the countless sacrifices you made while I pursued this degree.

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ABSTRACT

Tobacco use is the single most preventable cause of premature death and disability in the world. Every year six million people will die from tobacco-related diseases. To curb the growing tobacco epidemic, World Health Organization (WHO) adopted its first-ever global public health treaty, Framework Convention on Tobacco Control (FCTC) that obligates ratifying countries to implement a range of tobacco control policies. Most of the evidence for the effectiveness of the WHO's FCTC recommended tobacco control policies comes from high-income countries (HICs). This evidence suggests that as smoking prevalence declines in response to tobacco control policies and programs, the proportion of smokers who smoke less than daily increases and the number of cigarettes smoked by daily smokers decrease. There have been far fewer studies from low- and middle-income countries (LMICs) evaluating tobacco control policies, particularly from LMICs where non-daily smoking and light intensity smoking patterns have been dominant since before the implementation of FCTC-recommended tobacco control policies. This dissertation uses data from the 2008 – 2012 Mexico administration of the International Tobacco Control Policy Evaluation (ITC) project and the 2012 – 2014 Mexico administration of the Warning Wearout project 1) to examine the changes in cigarette consumption patterns of non-daily, daily-light (<=5 cigarettes

per day (CPD)) and daily-heavy smokers (>5 CPD) during the rapid implementation of tobacco control policies and identifying factors that are associated with changes in cigarette consumption (paper-I),2) to evaluate the impact of lack of secondhand smoke exposure at workplaces and hospitality industry venues on cessation behaviors and whether this association differs across smoking intensity groups(paper-II), and 3) to identify the correlates of responses to health warning labels (HWLs) (paper-III). In paper-I, we found that across the three smoking intensity groups, non-daily smokers were more likely to achieve abstinence at the follow-up, about a quarter of non-daily smokers continued to smoke at the same levels across follow-up periods, and reducing smoking intensity can be a stepping stone towards cessation for daily-heavy smokers. Perceived addiction was consistently important factor associated with changes in smoking consumption for all the three smoking intensity groups. For non-daily smokers only, anti-smoking social norms promoted smoking cessation. Paper-II findings suggest that lack of secondhand smoke exposure in workplaces and hospitality industry venues was unassociated with quit behaviors across the three smoking intensity groups. The smoke-free workplace and hospitality industry policies were limited in reach since only about a third of the study sample was exposed to these policies. In paper-III, we found that after a few years of implementing pictorial HWLs in Mexico, attention to HWLs declined over the study period while cessation-related responses to HWLs continued to increase over time. Also, HWLs in Mexico appear to be equally effective across socio-economic groups (SES) and for, some measures, slightly more effective among low SES groups than high SES groups. Taken together, results from this dissertation highlight the

need to design and study interventions that specifically target non-daily smokers who, despite not smoking every day, find it hard to quit. Also, it is recommended that the Mexican government should take additional actions to increase compliance to smoke-free policies and expand the policies to places where Mexicans continue to be exposed to SHS. Finally, LMICs that have limited resources should consider pictorial HWLs as a priority and rotate the content frequently to prevent wearout of HWLs.

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CHAPTER 1

Introduction

1.1: Statement of the problem

Tobacco use is the single most preventable cause of premature death and disability in the world. Tobacco use is a risk factor for six of the eight leading causes of death, and globally approximately six million people will die each year from tobacco-related diseases (1).The tobacco epidemic has been shifting from high-income countries (HICs) to low- and middle-income countries (LMICs) (2). Steady population growth and tobacco industry expansion in LMICs are promoting the tobacco epidemic. Unless urgent actions are taken, by 2030 more than 80% of the tobacco-related deaths will happen in LMICs (2). Hence it is very important to expand the focus of tobacco policy research to LMICs.

Tobacco consumption is responsible for 47,000 deaths (i.e., 10% of all deaths) each year in Mexico - a middle-income country (3). It is also estimated that the total healthcare expenditure associated with smoking in Mexico was at 75.2 billion pesos (US $ 5.7 billion) in 2008 (4). According to 2009 GATS, the adult smoking rates in Mexico were 15.9% (5) while the adolescent smoking rates in Mexico are alarmingly high – ranging by region from 11.5% to 26.8% in 2011 (6). In order to curb this growing tobacco

epidemic. On May 28, 2004, Mexico became the first country in the Americas to ratify the World Health Organization's Framework Convention on Tobacco Control (FCTC) – the first ever global public health treaty, which obligates ratifying countries to implement a range of tobacco control policies. Since then, Mexico has implemented stronger tobacco control laws, including tobacco taxes, smoke-free policies, marketing bans, and prominent pictorial health warning labels (HWLs) on cigarette packs (7).

Comprehensive smoke-free policies are among the most effective tobacco control strategies available and are the most effective way to protect nonsmokers from involuntary exposure to secondhand smoke (SHS) (8). Even though the primary goal of smoke-free policies is to eliminate non-smokers' exposure to SHS and thereby improve public health, a key "incidental" impact of the smoke-free policies is reducing the smoking rates and promoting quitting behaviors by shifting the social norms around smoking. Implementing health warning labels (HWLs) on cigarette packages is another policy recommended by the WHO FCTC. By 2013, 63 countries, constituting 40% of the world's population, have adopted pictorial HWLs. Large, prominent HWLs are effective in informing smokers about smoking risks and motivating them to quit and to remain quit (9-17). FCTC's Article 11 Guidelines advise countries to periodically rotate HWLs to prevent "wearout" of these warnings. As per this recommendation several countries, including Mexico, have implemented a HWL rotation strategy.

Most of the evidence for effectiveness of these tobacco control policies comes from HICs. There have been far fewer studies from LMICs, particularly LMICs where smoking patterns are different from those found in HICs. The context, enforcement and

effects of tobacco control policies in LMICs may not be comparable to HICs. Hence it is very important to study the effectiveness of tobacco control policies in LMICs and whether these effects are different from those found in HICs. This dissertation will provide insight into the smoking transitions of adult smokers over time and the effectiveness of two tobacco control policies—smoke-free policies and HWLs—in Mexico, a middle-income country where low intensity smoking is common. In particular, we examine the effectiveness of these tobacco control policies across different smoking intensity groups.

1.2: Study Aims and Hypotheses

The primary study aims for each paper are described below:

PAPER 1: ***Changes in cigarette consumption patterns of Mexican smokers***

Aim 1.1: To investigate the changes in cigarette consumption patterns of non-daily, daily light and daily-heavy Mexican smokers in urban Mexico, using data from the Mexican administration of the International Tobacco Control Policy Evaluation Survey (ITC-Mexico) waves III - VI.

Hypothesis A: Over time, Mexican non-daily and daily light smokers are more likely to reduce their cigarette consumption than to escalate to heavy smoking levels, and Mexican daily heavy smokers are more likely to maintain in the same levels than to reduce their consumption.

Aim 1.2: To identify the factors that are associated with progression to either a) heavier smoking levels among non-daily and daily light smokers or b) reduction or quitting among daily light and heavy smokers.

Hypothesis A:The quit behavior among daily-heavy smokers is primarily influenced by their perceived addiction and social norms may not influence changes in cigarette consumption for this group of smokers while the quit behavior among non-daily and daily-light smokers is influenced by social norms, i.e., weaker descriptive norms (i.e., having a smoking partner/spouse, more smokers among the five closest friends), stronger subjective norms (i.e., perception of what important people think about their smoking) and anti-smoking societal norms influence reduction or quitting among non-daily and daily-light smokers while measures of addiction influence quitting or reduction among daily-heavy smokers. Previous quit attempts and future intentions to quit influence the changes in cigarette consumption by the follow-u period for all the three groups of smokers.

PAPER 2: ***Impact of smoke-free policies on cigarette consumption patterns***

Aim 2.1: To evaluate the impact of self-reported exposure to secondhand smoke on quitting behaviors among Mexican adult smokers using data from ITC – Mexico waves III – VI.

Hypothesis A: Smokers who are not exposed to secondhand smoke at workplaces in the past month are more likely to have attempted to quit and to successfully quit than smokers who are exposed to secondhand smoke at workplaces in the past month.

Hypothesis B: Smokers who are not exposed to secondhand smoke in hospitality industry venues are more likely to have attempted to quit and to successfully quit than smokers who are exposed to secondhand smoke in hospitality industry venues. Smokers who have not been to hospitality industry venues in the past month are no

more likely to have attempted to quit and to successfully quit than smokers who are exposed to secondhand smoke in hospitality industry venues.

Aim 2.2: To examine if there is a differential impact of self-reported exposure to secondhand smoke on quit behaviors by the type of smoke-free policy among Mexican adult smokers using data from ITC – Mexico waves III – VI.

Hypothesis A: Compared to smokers who are not exposed to SHS at workplaces and hospitality industry venues in Mexico City, which has comprehensive smoke-free policy, smokers who are not exposed to SHS at workplaces and hospitality industry venues in places that implement the federal partial smoke-free policy are less likely to attempt to quit and quit successfully.

Aim 2.2: To examine if there is a differential impact of self-reported exposure to secondhand smoke on quit behaviors across different smoking intensity groups among Mexican adult smokers using data from ITC – Mexico waves III – VI.

Hypothesis A: Non-daily and daily light smokers are more likely to have attempted to quit and to quit successfully as a result of lack of exposure to Secondhand smoke at workplaces than heavy smokers.

Hypothesis B: Non-daily and daily light smokers are more likely to have attempted to quit and to quit successfully as a result of lack of exposure to Secondhand smoke at restaurants and bars than heavy smokers.

PAPER 3: ***Assessing the Correlates of Trajectories of Adult's HWL Responses***

Aim 3.1: To assess the correlates of trajectories of adult smokers' responses to health warning labels in Mexico using the first five waves of data from "Wear out" study.

Hypothesis A: At baseline, compared to daily heavy smokers, non-daily and daily light smokers report greater attention to HWLs and stronger cognitive and more frequent behavioral responses to HWLs. Compared to smokers with higher income, smokers with lower income report greater attention to HWLs and stronger cognitive and more frequent behavioral responses to HWLs. Compared to smokers with higher education, smokers with lower education report stronger attention to HWLs, stronger cognitive and more frequent behavioral responses to HWLs.

Hypothesis B: Over time, compared to daily heavy smokers, attention to HWLs and cognitive and behavioral responses to HWLs wearout at a slower rate among non-daily and daily light smokers. Over time, compared to smokers with higher income, attention to HWLs and cognitive and behavioral responses to HWLs wearout at a slower rate among smokers with lower income. Also, over time, compared to smokers with higher education, attention to HWLs and cognitive and behavioral responses to HWLs wearout at a slower rate among smokers with lower education.

1.3: Significance of Research

Tobacco use is the single most preventable cause of premature death and disability in the world (1) and the epidemic of tobacco use and related disease has spread to LMICs (2). The tobacco burden in Mexico is significant causing 10% of all deaths in Mexico (3). Since ratifying the WHO FCTC in 2004, Mexico has implemented a wide range of strong tobacco control policies. The cultural context and dominant smoking patterns in Mexico are different than those found in most HICs. Similar to several other LMICs, light (smoking daily at a rate of <= 5 cigarettes per day (CPD)) and

intermittent (smoking less than daily) smoking (LITS) is a dominant smoking pattern in Mexico. Two-thirds (64%) of Mexican smokers are low and intermittent smokers (5) and, compared to heavy smokers, they are more likely to attempt to quit (18). The strong tobacco control policies implemented in Mexico may provide an incentive for these low and intermittent smokers to quit smoking altogether.

Overall, this dissertation will elucidate the effectiveness of tobacco control policies across different smoking intensity groups, specifically the impact of workplace and smoke-free policies and pictorial HWLs across different smoking intensity groups. Though smoke-free policies are implemented primarily to protect non-smokers from SHS, promoting smoking cessation can be an important public health outcome of these policies. Also, the federal law in Mexico is not comprehensive as it allows for Designated Smoking Areas (DSAs) for smokers to smoke whereas the Mexico City has a comprehensive smoke-free policy that does not allow any DSAs. To my knowledge, this is the first study conducted in LMICs evaluating the impact of work-place and hospitality industry smoke-free policies on smoking behaviors and to compare the impact of comprehensive against partial smoke-free policies in promoting cessation. The first two papers of this dissertation are based on data from the ITC-Mexico project. The strengths of this study include the use of validated measures in a population-based sample, for which results may be generalized to Mexican smokers who reside in major urban settings. The results from these studies will help understand which smoking intensity groups are sensitive to the policies and to identify the groups of smokers that may need additional public health strategies to motivate and support them to quit. Also, to my

knowledge, the third paper of this dissertation is the first to evaluate impact of HWLs over time in a country where HWLs are regularly rotated as per the WHO FCTC recommendation. Also, very little is known about whether the wearout patterns differ across key population segments such as low-education, low-income and low intensity smokers in Mexico. If proven to be effective across population subgroups, the results of this study can inform HWL regulations that other countries adopt in order to reduce smoking and, ideally, smoking-related health disparities.

CHAPTER 2

Background

2.1: PAPER-I: CHANGES IN CIGARETTE CONSUMPTION PATTERNS

The natural history of cigarette smoking is often conceptualized as series of steps progressing from never use to trial, experimentation, established use, attempting to quit, relapse to smoking from quitting, and/or maintenance of cessation (19). The classic model of addiction suggests that cigarette consumption increases to a level where regular nicotine administration is necessary to help smokers avoid withdrawal symptoms (20). In the 1980's, an average smoker in the US smoked about 32 cigarettes per day (21). For a long time it was thought that established smokers smoked every day and that non-daily (intermittent) and daily light smoking were transitional or developmental stages on the way to established smoking (22). Most empirical research and theory development about cigarette consumption, addiction and quitting processes were modeled on daily heavy smokers (>= 10 CPD). Indeed, until 1992, most national population surveys of cigarette smoking in the United States did not even distinguish between daily and non-daily use.

Global trends toward light smoking patterns:

As the smoking prevalence in high-income countries (HICs) started to decrease over the past few decades, the rates of non-daily and daily light smoking have been increasing. For example, in the US, the prevalence of non-daily smoking increased from 17% in 1996 to 24% in 2001 – a 40% increase (23). Between 2005 and 2012, the percentage of smokers who consumed less than 10 cigarettes per day (CPD) increased from 16.4% to 20.8%, while the prevalence of current non-daily smoking among smokers remained around 22% during this time (24). In 2010, the prevalence of smoking less than 10 CPD among smokers in England was 33% and average non-daily smoking in countries of European Union ranged from 16% to 22% (25). All these estimates come from population-based surveys that rely on self-reports. Given that, compared to daily smokers, non-daily smokers are more likely to identify themselves as non-smokers, the prevalence estimates for light and intermittent smoking (LITS) are likely to be underestimated (22, 26). These trends toward lighter intensity smoking have developed in part as a result of tobacco control policies, including home and workplace restrictions and society's progressive denormalization of smoking (27). In fact, following the implementation of a variety of tobacco control policies in California in the 1990's, the prevalence of non-daily smoking increased from 26% of current smokers in 1992 to 28% in 2002 and to 30% in 2005 (26). Following the implementation of comprehensive tobacco control policies for 10 years in New York City, the adult smoking prevalence reduced by 28% from 2002-2012, the prevalence of non-daily smoking increased from

32% to 39% and smokers who consume more than 10 CPD decreased from 52% to 38% suggesting a shift in behavior to lower consumption patterns.

While the light (smoking daily at a rate of <= 5 cigarettes per day (CPD)) and intermittent (smoking less than daily) smoking (LITS) pattern is emerging in high-income countries, population-based surveys have consistently shown that the LITS pattern is highly prevalent and even a dominant pattern of smoking in many to low- and middle-income countries (LMICs). In countries such as Ecuador, Guatemala, Costa Rica, and Iraq about two-thirds of smokers are non-daily (1). In Mexico two-thirds (64%) of smokers are either non-daily or daily smokers who consume <= 5 CPD and the daily smokers smoke 9.4 CPD on average compared to 14.6 CPD in US (5, 28). In India, about 40% male and 20% of females cigarette smokers smoke less than daily (GATS – India) (1). In China 20% of male smokers and more than 40% of female smokers are non-daily smokers (1). In India and China alone, these numbers translate to millions of non-daily smokers.

Racial / ethnic differences in smoking patterns:

LITS patterns found in Mexican and Central American LMICs are echoed in population heterogeneity of smoking patterns across racial / ethnic groups in the US. Earlier studies that analyzed nationally representative data showed that even after adjusting for socio-demographic factors, ethnic minority smokers, including African Americans, Asians, Pacific Islanders, and Hispanics/Latinos, were more likely to be LITS in comparison to non-Hispanic Whites (29-35). The LITS pattern among Hispanic / Latino smokers contrasts most strikingly with non-Hispanic Whites. Latinos were over three

times more likely to smoke intermittently and over four and half times more likely to smoke fewer than 5 CPD compared to Whites (30). Among Hispanic / Latinos, compared to heavy smokers, LITS smokers were typically male, from Mexican and Central American origins, less nicotine dependent, had fewer friends that smoked, had lower levels of perceived stress and were most likely to live in a home with an indoor smoking ban (35, 36). However, these LITS Latinos smokers in comparison to Latino heavy smokers were no more likely to quit following cessation treatment (35, 37). It is estimated that by 2050, about 30% of the US population will be from the Latino minority groups that historically have been smoking at light and intermittent levels (38). Given that there is an impending light smoking epidemic, it is very important to understand the effectiveness of tobacco control policies in this sub-population.

Health Implications of light and intermittent smoking:

Scientific understanding of the health risks from smoking are primarily based on research with adult daily heavy smokers (more than 10 CPD). Our understanding of the health impacts of light and intermittent smoking is very limited. There have been a few studies that looked at the health implications of such smoking patterns. Inconsistencies in defining daily light smoking (<= 10 CPD versus <=5 CPD) and failure to account for daily versus non-daily smoking makes it more challenging to understand the true health implications of LITS(26, 41-46). A recent review by Schane et al looked at the available limited literature that examined health effects of LITS and indicated that LITS possess substantial health risks (47). Compared to non-smokers, LITS have increased risk for cancer, myocardial infarction, and cardiovascular mortality (41-46). There are not

enough studies to understand the effects of LITS on cerebrovascular, COPD and breast cancer (47). Though research shows that LITS poses significant health risks, to improve our understanding of the full range of health effects of these smoking patterns, there is a great need to conduct large-scale prospective cohort studies that distinguish between daily heavy, LITS.

These health implications underscore the importance of understanding the patterns and natural history of LITS. We know very little about how LITS develops over an individual's smoking history or how smokers move from LITS to heavy smoking levels or to quitting. Also, the characteristics that are predictive of each of these outcomes is very limited. Though light and intermittent smokers are at greater risks for negative health outcomes than non-smokers, there is evidence building on decreased mortality risk among heavy smokers who substantially reduce their consumption level and remain smoking at very low levels compared to heavy smokers who continue to smoke at similar rates (48). Hence it is important to understand the characteristics of smokers who reduce their consumption intensity and maintain smoking at low levels.

Cigarette consumption patterns and factors associated with various patterns:

Cross-sectional studies:

Using cross-sectional data, early studies conducted in the US on light (< 10 CPD) and intermittent smokers focused on the socio-demographic and smoking-related factors that are related to LITS (34, 49-52). In general, these studies showed that compared to daily heavy smokers, LITS were more likely to be younger, female, non-White, better educated, have higher incomes. Also, compared to daily heavy smokers,

LITS were less likely to start smoking at younger age(34), to perceive themselves as addicted to smoking(49, 51, 52), to smoke while stressed(51, 52). Compared to daily heavy smokers, LITS were more likely to wait longer in the day to smoke(51, 52), to have attempted to quit previously(49)to have plans to quit in the near future(49) and to live and work in environments that have smoking bans(49). The studies that focused on LITS among non-Latino minorities also showed similar groups of characteristics as predictors of light smoking among Latinos (29, 30, 33, 37, 53). Apart from those characteristics, LITS Latinos were less likely to be of Puerto Rican origin than from other Latin countries (33). Income and education, however, were not predictive LITS among Latinos (29, 36, 37, 53).

Longitudinal studies in different population groups:

Studies of young adults:

Studies conducted among college students in the US found that heavy smoking was the most stable group among young adults over a period of 4years (54-56). More than half of occasional smokers eventually quit (54-56), although those involved in binge drinking were more likely to transition to daily smoking (55). Among young women (18 – 23 years), binge drinking, being single, not having kids and using illicit drugs were all predictors of transitioning to heavy smoking levels (57). Given that young adult light smokers are more likely to quit than to increase their consumption, they may even be more receptive of tobacco control interventions.

Studies on adults:

The majority of studies about smoking transitions among adult smokers are of limited utility for understanding LITS. These studies either did not distinguish between daily light smokers and daily heavy smokers (34, 58-60), used retrospective study designs to assess baseline smoking status (34), or studied very specific population groups (e.g., older population (59) or working population (58)). These studies compared cessation-related outcomes among occasional and daily smokers and found that occasional smokers were more likely to quit at the follow-up than to escalate to daily smoking (34, 58, 59). Among workers, feeling monotony at work was associated with transition to daily smoking while changing to a workplace that has more restrictive smoking policy was associated with quitting (58). One study has looked at stability of cigarette consumption only among continuing smokers (61). Continuing smokers who were unwilling to quit did reduce their consumption over time and factors such as making a quit attempt, even if unsuccessful, and experiencing smoking bans at work and home predicted reductions in consumption (61). Following up smokers semiannually for 3 years, a study conducted by Bondy et al examined the smoking transitions among 4,355 baseline smokers and found that the future smoking status among occasional (non-daily) smokers depends on their smoking history and subjective dependence (60). The continuing occasional smokers reported fewer intentions to quit and were less likely to attempt to quit despite considering themselves less addicted. Daily smokers who turned to occasional smokers at first follow-up were more likely to rebound to daily smoking status during subsequent follow-ups. Whereas daily smokers who quit for more

than 30 days at the first follow-up were more likely to remain quit during the subsequent follow-ups. Similarly, Cheong and colleagues reported that smokers who quit cold turkey were more likely to be smoke free for more than 30 days than those who gradually cut down to quit (62).

Very few longitudinal studies looking at smoking transitions differentiated between non-daily, daily light and daily heavy smoking (63-67) . Also, the cut points used to distinguish daily light and daily heavy smoking were not consistent (<10 CPD (63, 65) vs <= 5 CPD (64, 66, 67) as daily light smoking). In general these studies showed that the natural history of daily light smoking to be very fluid and non-daily smoking as a more stable group. Despite exhibiting lower nicotine dependence, non-daily smokers were no more likely to attempt to quit than the daily heavy smokers (64, 66, 67), but they were more likely to successfully quit at the follow-up periods compared to daily light and daily heavy smokers (63-67).

Among all the studies that looked at smoking transitions among adults, to my knowledge there has been only one study that looked at the predictors of these smoking transitions (66). This study showed that among very light (<= 5 CPD) smokers, not smoking daily, smoking mostly with friends, planning to quit in next 30-days, and living in homes with smoking bans were all independent predictors of quitting over a 2-year follow-up period. Among very light smokers, being White, smoking daily, being highly nicotine dependent, and having more smoking friends were all predictive of transitioning to heavy smoking levels at 2-year follow-up. Daily heavy smokers who had higher self-efficacy in quitting, and who made a 24-hour quit attempt in the past year

were more likely to either maintain or reduce consumption than to increase it. The majority of smokers in this study were Whites from the US who historically had higher smoking intensities than ethnic minority groups such as Latinos and Asians.

Studies on ethnic minorities:

Two longitudinal studies (35, 37) conducted among Latinos in the US have looked at smoking transitions during a cessation intervention. Though light smokers (<10 CPD) reported less nicotine dependence, they were not any more likely to quit by the follow-up periods than heavy smokers (35, 37). These studies did not include non-daily smokers. Similarly, a longitudinal study conducted in Mexico (18) looked at smoking intensity at baseline and cessation behaviors at a 14-month follow-up period concluded that non-daily and daily light smokers were more likely than daily heavy smokers to have attempted to quit. Also, compared to daily heavy smokers, non-daily smokers but not daily light smokers were more likely to succeed in quitting by the follow-up period. To my knowledge this is the only longitudinal study conducted among Mexican smokers. However, this study focuses on only quit behaviors at the follow-up and does not look at the changes in consumption patterns at the follow-up. Also, this study had data from only one follow-up period.

Summary of background:

Over the past two decades, as the overall smoking prevalence has declined in high income countries, patterns of LITS have become more prevalent. This pattern is most common among US ethnic minorities and it is also common in several LMICs. In Mexico alone, about 77% of current daily smokers smoke less than 11 CPD (5). Existing

public health guidelines on identifying and treating smokers, and the information on health risks caused by tobacco use, are based on research conducted among adult daily smokers in HICs. Although, epidemiological studies have shown a dose response for most adverse health outcomes related to smoking, even smoking at very low levels (<= 5 CPD) has health implications (47). These implications underscore the importance of understanding the natural history of light smoking.

Previous longitudinal studies have shown that light smoking is a highly unstable pattern and light smokers are more likely than heavy smokers to either increase consumption and become heavy smokers or to reduce their consumption and even quit(63-67). However, most of these studies were conducted in the US, where light smoking is defined as smoking less than 10 cigarettes per day. There was no consistency in prior research for the cut off points used to define light smoking (some studies used less than 10 CPD and some used a non-daily group). Few studies looked at the transitions of smoking among non-daily and daily smokers who consume 5 or less CPD separately. Some of the studies are conducted in specific populations of interest, such as young adults or working populations, and therefore have limited generalizability.

Since Mexico has ratified FCTC in 2004, a wide range of tobacco control policies have been implemented. From a public health perspective, it is important to understand which groups of smokers are quitting and which smoking groups are escalating to higher intensity levels. This understanding will help develop future public health interventions including those that may require targeting particular groups. Additionally, to the best of my knowledge, there have been no studies of changes in smoking patterns over time in

LMICs where LITS is the dominant smoking pattern. Given the growth of the LITS pattern, research in Mexico may be useful for informing research and tobacco control policy development in other LMICs.

2.2: PAPER II: IMPACT OF SMOKE-FREE POLICIES ON CIGARETTE CONSUMPTION PATTERNS

Smoke-free policy evaluation – Evidence from high-income countries:

The WHO Framework Convention on Tobacco Control (FCTC), the first ever global public health treaty, under article 8, mandates ratifying countries to adopt effective smoke-free laws to protect citizens from exposure to tobacco smoke in workplaces, public transport and other indoor public places (68). Guidelines adopted by the treaty's governing body make it clear that only comprehensive smoke-free policies that cover all indoor public places and workplaces that do not allow for designated smoking rooms (DSAs) or separate ventilating systems meet the treaty requirements. So far, 92 countries have national smoke-free laws, of which 62 countries have comprehensive smoke-free laws that cover 100% of bars, restaurants and non-hospitality workplaces (69). However, 93% of world's population is still living in countries that are not covered by comprehensive smoke-free policies (70). The primary goal of smoke-free policies is to eliminate exposure to secondhand smoke (SHS) and improve health outcomes among non-smokers. A key "incidental" impact of the smoke-free policies is reducing the smoking rates and promoting quitting behaviors. Smoke-free policies send a strong message into the community that smoking is no longer

socially acceptable and thus strengthening the anti-smoking social norms (71). Comprehensive smoke-free policies also reduce opportunities for a smoker to smoke.

There have been several studies conducted in the past two decades evaluating the effectiveness of smoke-free policies in reducing the SHS and improving the health outcomes. Most of this evaluation work has been conducted in high-income countries. Research has shown that implementation of comprehensive smoke-free policies can rapidly improve respiratory and cardiac health outcomes among smokers and non-smokers (72-78). A recent meta-analysis of existing literature on smoke-free policies and health outcomes found that smoke-free legislation is associated with a lower risk of smoking-related cardiac, cerebrovascular, and respiratory diseases. This study also found a dose-response relationship suggesting that more comprehensive laws are associated with greater reductions in risk (79).

Population-based studies across different settings and in various high-income countries have also shown that comprehensive smoke-free policies are effective in increasing the support for smoke-free policies, increasing home and car smoking bans, and reducing social acceptability of smoking (19, 80-86). Support for policies has generally been very high following implementation, even among smokers (19, 81, 87).Compliance with smoke-free policies is generally high except for bars in some countries, and any resistance to smoke-free policies dissipates over time (19, 81, 83, 87-89). Air quality studies have consistently shown that implementation of smoke-free policy leads to dramatic reductions in indoor air pollution. The levels of Particulate Matter (PM) 2.5 were on average 87% lower in countries that have comprehensive

smoke-free policies in comparison to countries that do not (90). In Ireland, the first country to implement a national comprehensive smoke-free law, levels of PM2.5 were 93% lower in smoke-free pubs than in pubs that allowed smoking (91). Also in Ireland, smoking in workplaces declined from 62% to 14%, from 85% to 3% in restaurants, and from 98% to 5% in bars and pubs in the 9 months after implementation of the law (81). There was a concern that smoke-free policies would displace smoking from bars and restaurants into the homes of smokers. However, the number of smoke-free homes increased in Australia, Canada, France, Germany, Ireland, The Netherlands and United Kingdom following the implementation of smoke-free policies(81, 84-86), suggesting that smoke-free policies shift social norms so that smoke-free policies are adopted in places that are not regulated by the law.

Smoke-free policy evaluation – Evidence from low- and middle-income countries:

In the past decade there have been a few studies conducted in LMICs to evaluate smoke-free policies. Air quality studies conducted in LMICs showed that implementation of comprehensive smoke-free laws was followed by dramatic reductions in indoor air pollution. There was an overall 91% reduction in airborne nicotine concentrations in Uruguay public places and worksites following the implementation of national comprehensive smoke-free air policy in 2006 (92). Another air quality study conducted in Sao Paolo, Brazil, showed statistically significant decreases in CO concentrations in ambient air and exhaled breath of both smoking and non-smoking workers following the comprehensive smoke-free policy implementation in 2011 (93). Following the Mexico City comprehensive smoke-free policy in 2008, self-

reported exposure to SHS was reduced from 35% to 25% in indoor workplaces, 100% to 30% in bars and 75% to 5% in restaurants (94), suggesting that comprehensive smoke-free policy implementation in LMICs may lead to significant decreases in exposure to SHS despite a significant degree of non-compliance in bars and workplaces (94-96).

However, countries that enacted partial smoke-free laws that allow DSAs experienced more difficulties with compliance to smoke-free policies and have not produced reductions in SHS exposure that were found with comprehensive policies (94, 97, 98). Chile enacted national legislation restricting smoking in public places and workplaces in 2007 (99). The legislation, however, allowed bars and restaurants <100 m^2 for public use to decide their smoking policy (smoke free or smoking) and bars and restaurants >100 m^2 for public use to designate smoking and non-smoking areas physically separated from each other. The air nicotine concentrations measured in bars and restaurants in Santiago, Chile, remained high following implementation of its partial smoking ban legislation in 2007 (98). China enacted a national smoke-free law that restricted smoking in few workplaces. Workers at these smoke-free locations reported exposure to SHS while at their places of employment (100). Also, comprehensive smoke-free policies in Mexico City have been shown to be more effective in reducing the exposure to SHS than partial smoke-free policies in other Mexican cities (101).

Even though the level of compliance in LMICs is not as high as compliance in HICs following comprehensive smoke-free policies, the smoke-free policies in LMICs have also been effective in improving population health. In Uruguay, within two years of smoke-free policy implementation, the number of hospital admissions for acute

myocardial infarction decreased by 22% (102). In Argentina, the 100% smoke-free Santa Fe law was more effective than the Buenos Aires partial law in reducing acute coronary syndrome hospital admission (103). Another study conducted in Neuquén, Argentina, showed a statistically significant decrease in respiratory symptoms in bar and restaurant workers after implementation of a provincial smoke-free law (104). These improved health outcomes suggest that better compliance to the smoke-free policies in these LMICs could lead to even greater public health benefits.

Impact of Smoke-free policies in shifting the social norms leading to cessation:

Though the primary goal of smoke-free policies is to eliminate exposure to SHS and improve public health, a key "incidental" impact of the smoke-free policies is reducing smoking rates and promoting quitting behaviors. The mechanism by which smoke-free policies reduce smoking rates may be two-fold. First, smoke-free policies send a strong message into the communities that smoking is no longer socially acceptable (71), thus strengthening anti-smoking community norms. Second, by limiting smoker's opportunities to smoke, thus raising the "cost" of smoking (e.g., having to go outside to smoke), smoke-free policies may reduce the perceived benefits of indulging in smoking behavior (e.g., the "pleasure" of smoking a cigarette after meal). Once quit, smokers may find it easier to remain abstinent in a smoke-free environment – cues to smoke from other smokers smoking would be less frequent (105, 106). By providing fewer cues to smoke, smoking restrictions in the hospitality industry, especially bars and clubs, may hinder transition to heavier levels of smoking, particularly among young

smokers and those who go to these places more often (107). Workplace smoking restrictions may also help intermittent smokers not to transition to daily smoking (108).

There have been a few studies that examined the mediating role of social norms in changing smoking behaviors after implementation of smoke-free policies. Among smokers from the US, the UK, Australia and Canada, baseline self-reported exposure to stronger smoke-free policies at workplaces and restaurants was associated with stronger baseline antismoking norms, which in turn predicted having quit after 9 months (109). Immediately following implementation of smoke-free policies, smokers from Canada and Ireland reported changes in their perception of smoking behaviors at home and in cars, and they reported viewing smoke-free policies as a motivation to change their smoking behavior (81, 110). Both adults and youth living in Massachusetts towns with strong tobacco regulations that included comprehensive smoke-free policies perceived stronger antismoking norms than those living in towns with no strong tobacco regulations (111). Another longitudinal study conducted in 351 Massachusetts towns examined the effect of smoke-free policies in local restaurants on anti-smoking attitudes and quitting behaviors among smokers (71). This study found that smoke-free policies in restaurants reinforce anti-social smoking norms among smokers who already view smoking as socially unacceptable, and these policies encourage smokers to make new quit attempts. These studies show that smoke-free policies promote cessation by reducing the social acceptability of smoking, suggesting that government regulations act as statements of norms which influence perceptions and behaviors.

Impact of Workplace Smoke-free policies on smoking behaviors:

There have been several studies that looked at the impact of smoke-free policies on smoking behaviors. Most of the earlier work was focused on evaluating the impact of smoking restrictions at worksites on smoking behaviors across various countries such as US, Canada, Australia, Switzerland and Germany (85, 112-117) . These studies in general showed smoke-free worksites reduced smoking prevalence and promoted quitting behaviors among smokers. Both the studies of individual worksites and population-based studies of worksites showed that worksite smoke-free policies result in an immediate reduction in quantity smoked among continuing smokers (85, 113, 116, 117). These studies reported about 10 – 15% reduction in the amount of cigarettes smoked. This reduction in the amount smoked was greatest in the first 6months of policy implementation and then decreased over time. The impact of smoke-free policies on quit behaviors generally showed little or no immediate effect, but the effects became more apparent over longer periods of time. This could be one of the reasons why the impact of smoke-free worksites on cessation behaviors was less conclusive in studies with short duration. Population-based studies with longer duration of follow-up showed that worksite smoke-free policies resulted in increased number of quit attempts and at least 10 – 15% higher cessation rates in worksites that implemented the smoking bans (85, 114, 115). This impact was greater for workers who worked for longer hours, suggesting a dose-response relationship (114).

A review by Fichtenberg and Glantz looked at 26 studies on the effectiveness of smoke-free workplaces across US, Australia, Canada and Germany and reported that

complete smoke-free workplaces were associated with 3.8% reduction in prevalence of smoking and 3.1 fewer cigarettes smoked per day in continuing smokers (118). Though the review grouped together different smoking restrictions such as worksite, schools, restaurant and public places, most of these 26 studies were specific to smoke-free policies at workplaces. Another review conducted by Levy and Friend estimated that clean indoor air laws in worksites could reduce cigarette consumption and smoking prevalence by 10% (112).

Impact of National Comprehensive Smoke-free policies on smoking behaviors:

Over the past quarter century smoke-free policies have spread rapidly from workplaces to all enclosed public and private places. Following the local- and state-level smoke-free policy enactment, countries started to pass national comprehensive smoke-free policies that cover all enclosed private and public places including restaurants and bars. Studies that evaluated hospitality industry smoke-free policies and national comprehensive policies on cessation behavior have been inconclusive, and several studies have shown no impact on cigarette consumption and cessation (71, 119-125)). Studies that collected data at shorter intervals before and after implementation of the policy captured some changes in smoking behaviors (88, 122, 126-129). In England, for example, the comprehensive smoke-free policy was introduced on July 1, 2007. A study that looked at smoking behavior information collected by month found that attempts to quit smoking were greater during the two-months following the implementation of the smoke-free policy in comparison to an analogous 2-month period the following year (127). Also, an analysis using the 2007 Health Survey of England found significant

reduction in cotinine levels among men(316 ng/ml to 276 ng/ml) and women (277 ng/ml to 250 ng/ml) in the six months after the implementation of smoke-free policy, suggesting that the smoke-free policy might be associated with a decline in daily cigarette consumption among continuing smokers (88). If consumption is reduced, some smokers might find it easier to eventually successfully quit (129, 130). Another study conducted in Scotland also found that the introduction of a smoke-free policy was associated with a significant increase in nicotine replacement therapy (NRT) and increased contacts with cessation services (126, 128).

The studies that show an immediate temporary increase in quit attempts, reduction in amount smoked, usage of cessation services and increased smoking quit ratios suggests that smoke-free policies are effective in bringing some changes in smoking behaviors. Following the implementation of smoke-free policy, England has reduced the value-added tax on NRT. A study using ITC data evaluated the smoke-free policy in England, Ireland and the Netherlands and found that the smoke-free policy was associated with short temporary increase in quit attempts in Ireland, increased quit success in England and no significant effect on quit attempts or quit success in the Netherlands as a result of its partial smoke-free policy (131). In Ireland and the Netherlands there was no emphasis on cessation support. So the observed increase in quit success in England could be a cumulative effect of smoke-free policy and reduced value-added tax on NRT.

The studies that looked at changes in national smoking trends as a result of national comprehensive smoke-free policies did not find any statistically significant

associations (88, 119). A study conducted in Italy evaluated its 2005 smoke-free policy using 11 nationally representative cross-sectional studies conducted from 1999 – 2010 (119). This study used interrupted time-series analysis and found that implementation of a smoke-free policy was associated with a significant decrease in smoking prevalence and an increase in smoking cessation for men and low-educated women. However, these favorable trends reversed in the years following the implementation of smoke-free policy, which could be the result of reduced compliance with smoke-free policy over time in Italy. Another study conducted in England employed nationally representative cross-sectional surveys from 2003-2008 and evaluated the effectiveness of smoke-free policy on smoking behaviors (88). By adjusting for the declining smoking trends, this study found that the national smoke-free policy was not associated with additional declines in smoking prevalence or daily cigarette consumption in the 18months following the implementation of smoke-free policy. A recent study looked at trends in population-level smoking prevalence for 53 countries and states within the US that have comprehensive smoke-free policies covering bars, restaurants, and work-places, with no designated smoking rooms (123). This study used segmented regression analysis that adjusts for the confounding effect of secular declines in smoking prevalence before smoke-free law implementation and found that comprehensive smoke-free policies were associated with declining smoking prevalence in some jurisdictions, but did not find an impact in the majority of places.

These national-level smoking trend studies suggest that the encouraging immediate changes in perceptions and smoking behaviors may not have translated into

reductions in smoking prevalence. However, several factors could have influenced the lack of association between comprehensive smoke-free policy and reduction in smoking prevalence. Several local and state-level jurisdictions implemented comprehensive smoke-free policies before a nation-wide policy went into effect. Hence the incremental effect of smoke-free policies on reduction in smoking might be minimal. Also, several strong tobacco control measures, such as worksite smoke-free policies, cigarette tax and advertising bans etc., were enacted before the implementation of the comprehensive smoke-free policies in several of the HICs. Hence it is possible that the smokers remaining at the time of comprehensive smoke-free policy implementation were 'hardened smokers' who find it most difficult to quit (123).

The context and setting in Netherland has given an opportunity to evaluate the effectiveness of the workplace smoking ban implemented in 2004 and the smoke-free policy in the hospitality industry that was implemented in 2008 (122). This study analyzed population-based cross sectional surveys from 2001 – 2008 and found that the workplace ban was associated with a significant decrease in smoking prevalence, whereas the hospitality industry smoking ban was not. Both the workplace and hospitality bans were associated with an increase in quit attempts and successful quitting. However, the successful cessation following the hospitality industry ban has not translated to statistically significant reductions in smoking prevalence. Notably, in the Netherlands the hospitality industry smoking ban was not followed by strong enforcement (132) . Several bars did not comply with the smoke-free policies.

In conclusion, smoke-free policies do influence smoking behaviors by shifting the norms and reducing smoking opportunities. Reviewing the smoke-free policy evaluation literature indicates that workplace smoking bans had greater effect on smoking behaviors than hospitality industry bans. People spend more time at worksites, and any restrictions at the worksite are expected to influence behaviors more. People spend far less time in restaurants and bars, and hence the hospitality smoking bans might not be associated with greater reductions in smoking prevalence. Comprehensive policies were more effective in bringing changes in smoking behaviors than partial smoke-free policies. Also, in high-income countries, national smoke-free policies were implemented after implementation of other strong tobacco control policies, such as worksite smoke-free policies, local jurisdiction comprehensive smoke-free policies, cigarette taxes and advertising bans. So the additional impact of national comprehensive smoke-free policies might have been minimal. In LMICs there is very limited research conducted to understand the effectiveness of smoke-free policies in these countries.

Context in Mexico:

On May 28, 2004, Mexico became the first country in the Americas to ratify the WHO FCTC. Before 2007, smoke-free policies in Mexico were limited to government buildings and hospitals (133), and compliance was generally very low (134). In February of 2008, Mexico City adopted the Smoke-Free Workplace Act, which completely prohibits smoking in enclosed public places (i.e., bars, restaurants), workplaces, and in public transportation (135, 136). This law became effective on April 3, 2008, making Mexico City Mexico's first 100% smoke-free city.

In May 2008, the Mexican President signed the General Tobacco Control Law (GLTC) (137) that prohibited most types of tobacco product advertising, stipulated pictorial health warning labels on cigarette packages, and established smoke-free areas within public places and workplaces. The GLTC went into effect in August 2008. However, the regulations enforcing GLTC were not published until May 2009, after which states only gradually adopted legislation that conformed to this law. Under articles 26 to 29 of GLTC, smoking is prohibited in indoor public places and workplaces, as well as in primary, secondary and high schools. However, the law allowed designated smoking areas (smoking only areas) as long as they had a separate ventilating system and were physically separated by walls from the rest of the venue.

According to 2009 Global Adult Tobacco Survey (GATS) – Mexico that was conducted before the adoption of federal smoke-free regulations, among those who work indoors or in enclosed areas, 19.7% of Mexicans (3.8 million) were exposed to SHS at work, of which 17.7% (2.6 million) were non-smokers (5). Exposure to SHS was highest in bars and night clubs - about 81.2%, while in restaurants it was 29.6%, in public transportation 24.2%, in government buildings 17.0%, and 4.3% in health care facilities. Among the 68.8 million adults aged 15 and older in Mexico, 17.8% (12.2 million) allowed smoking in their home; and 6.4% were exposed to smoke in their home daily. Approximately 11.9 million Mexicans (17.3%) were exposed to smoke monthly inside their homes.

In Mexico, like most LMICs, the smoke-free policies were limited to government buildings and hospitals until the national smoke-free law was implemented. The

implementation of a comprehensive smoke-free policy in Mexico City resulted in increased support for 100% smoke-free policies, an increase in the social unacceptability of smoking, higher agreement that smoke-free policies improve health and reinforces rights, and declines in exposure to SHS within 8 months of policy implementation (96). However, the support for the policy and compliance were lower for bars than in other regulated venues. Also, the reduction in SHS exposure and support for smoke-free policies were greater in Mexico City than in three other Mexican cities that implemented the federal smoke-free policies, suggesting that comprehensive smoke-free policies are more effective than partial smoke-free policies (94).

To my knowledge, there have been no studies that have evaluated the effectiveness of smoke-free policy in modifying smoking behaviors in LMICs. All of the evidence for smoke-free policy effects on smoking behaviors comes from HICs. Furthermore, the cultural context and smoking intensity in Mexico are quite different from HICs. Latinos in the US were more likely to view their smoking as a result of social and environmental cues and less of physical dependence. Additionally, they cited concerns about family and interpersonal relations as important reasons to quit (32, 33). This cultural context might lead smokers to be more supportive of smoke-free policies in Mexico since these policies reduce the environmental smoking cues for a smoker and send a strong message into the community that smoking is unacceptable and SHS is dangerous for non-smokers. Hence, smoke-free policies might have greater effect in promoting smoking cessation among Latinos. Also, Mexican smokers are more likely to be non-daily smokers and to consume a lower number of cigarettes per day (CPD)

compared to smokers from majority ethnic groups in western countries. Smokers with lower-levels of consumption reported less tobacco dependence (18) and experienced fewer cravings during the quit attempt compared to heavier smokers (37), suggesting that quitting may be easier for this subpopulation. A study conducted in the US showed that non-daily smokers respond to the environmental smoking cues such as being with smoking friends, and being in a bar much more strongly than the daily smokers. Also, environmental restrictions such as smoke-free policies are more effective in positive behavioral changes among non-daily smokers in comparison to daily smokers (138). Hence, smoke-free policies may serve as a cue for light smokers to succeed in their attempts to quit eventually. So far, the effect of smoke-free policies on smoking behaviors has been studied in populations that smoke at higher levels (>20 CPD). To my knowledge there have been no studies to date that have looked at the effects of smoke-free policy on a population of light smokers. Light smoking is a phenomenon that is unevenly distributed over time and context (51). Existing evidence does not show how the changes in policies affect smoking behavior among light smokers.

Summary of background:

The primary goal of smoke-free policies is to reduce the exposure to SHS and thus improve health outcomes among non-smokers. A key incidental outcome of smoke-free policies is promoting smoking cessation by shifting the social norms around smoking and sending a strong message into the community that smoking is no longer socially acceptable. Studies from HICs have shown that smoke-free policy implementation leads to changes in people's perceptions about smoking, reduced

exposure to SHS and improved health outcomes. Implementation of comprehensive smoke-free policies in LMICs also led to reduced exposure to SHS. However, the level of compliance in LMICs is lower than HICs.

Studies evaluating workplace smoke-free policies in HICs have consistently shown that smoke-free workplace laws are effective in promoting cessation among smokers. However, studies that evaluated the impact of comprehensive smoke-free policies have been inconclusive. To my knowledge, no studies conducted in LMICs have evaluated the impact of smoke-free policies on smoking behaviors. In general, LMICs have limited cessation resources. Hence, even though smokers report greater intention to quit, the successful quitting rates are low in LMICs. If smoke-free policies in LMICs are effective in promoting smoking cessation, this will be an additional motivation for countries to implement comprehensive smoke-free policies. Also, Mexico has an overwhelming proportion of light intensity smokers. Global trends in smoking suggest an impending light smoking epidemic. To my knowledge, there have been no studies that have evaluated the effect of smoke-free policies among light-intensity smokers. Light-intensity smokers are less likely to identify themselves as smokers and are less likely to receive cessation advice than heavy smokers. Therefore, it is important to understand whether smoke-free policies are promoting cessation in both light and heavy smokers, at the least, in similar ways.

The objective of the present study is to evaluate the effectiveness of Mexico's federal smoke-free policy and Mexico City's comprehensive smoke-free policy on smoking behaviors using the conceptual model presented below in Figure 1. This model

is adopted from the ITC conceptual model for evaluating the tobacco control policies under the FCTC treaty (139). The ITC conceptual model was developed based on models from the health communication theories and the psychosocial literature such as the theory of planned behavior(140), social cognitive theory(141), the Health Belief Model (142)and the Protection Motivation Theory(143).This model hypothesizes that smoke-free policies influences individual behaviors first by influencing the factors that are most proximal to the policy itself, such as support for the policy and awareness of SHS risks, which in turn influence psychosocial mediators such as self-efficacy to quit and quit intentions. Changes in psychosocial mediators in turn are expected to influence policy-relevant outcomes such as quit attempts and quit success. Moderator variables help determine if the policy has any differential effect across population subgroups.

2.3: PAPER III: ASSESSING THE CORRELATES OF TRAJECOTIES OF ADULT'S HWL RESPONSES

Introduction to HWLs:

Tobacco use is the single most preventable cause of premature death and disability in the world and approximately 6 million people will die each year from tobacco-related diseases (1). Despite the conclusive evidence about the harms caused by smoking, relatively few smokers understand the full extent of their health risks (144). Most smokers agree that smoking is a health risk. However, their understanding of the full range of diseases caused by smoking is limited (13, 145-148). Smoker's knowledge of health risks has a strong influence on their smoking behavior and is one of the

predictors for quit behavior among smokers, and for long-term abstinence among former smokers (13, 149, 150).

Communicating the health risks of smoking and promoting smoking cessation remains the primary objective of tobacco control policies and programs. The World Health Organization's first ever world treaty, the Framework Convention on Tobacco Control (FCTC), has as a guiding principal that "every person should be informed of the health consequences, addictive nature, and mortal threat posed by tobacco consumption and exposure to tobacco smoke" (Guidelines for article 11) (1). Under article 11, FCTC stipulates that warning labels should be implemented within three years of treaty ratification. These warning labels "should be 50% or more of the principle display areas but shall be no less than 30% of the principle display areas" and "may be in the form of or use pictures or pictograms" (1).

HWLs constitute the most cost-effective tool for educating both smokers and non-smokers about the harms of tobacco use, and it is one of the most widespread policy initiatives implemented to educate smokers. By 2013, 63 countries have finalized pictorial HWLs; more than 40% of the world's population is now exposed to pictorial health warning labels on cigarette packages. Three countries (Australia, Sri Lanka, Uruguay) require warnings to cover as much as 80 percent of the package and 18 countries or jurisdictions have warnings covering more than 50% of the package front and back (151). Many other countries are moving towards revising their HWLs.

Impact of HWL's on health beliefs and attitudes and quit behaviors:

HWLs on cigarette packages have been shown to be the most direct and prominent means of communicating health risks of smoking to smokers. In many countries, smokers rate HWLs as their primary source of information about health risks of smoking after television(152). More than 85% of smokers from countries with large pictorial HWLs cited cigarette packs as a source of health information (15). However, more obscure warnings that are not prominent or not present on the main face of the pack but on the side of packages, such as in the US, are associated with low-levels of attention to HWLs (i.e., noticing and reading HWLs), poor recall and low levels of awareness of smoking risks (13, 153, 154).

Research has consistently shown that HWLs with prominent pictures are more likely to be noticed and read by smokers, and are associated with stronger beliefs about the health risks of smoking (9, 10, 12, 13, 148, 155, 156). Smokers have consistently reported that large text and pictorial HWLs helped them reduce the amount they smoked, increased their motivation to quit and increased their likelihood to remain abstinent following a quit attempt (9-17). HWLs have also been associated with increased use of cessation services (157-160). Countries such as Australia, Brazil, The Netherlands, and the UK displayed contact information of national telephone hotlines on cigarette packages as part of their new HWLs policy. Studies conducted in these countries reported significant increases in call volumes following the introduction of new warnings (157-160). Another experimental study has shown that graphic imagery on the cigarette packs led to reduction in demand for the pack (161).

Impact of HWL's across different socioeconomic groups:

Health communication research has shown that disadvantaged populations may differ in their ability to access, process and act on health information leading to "communication inequality" (162, 163). This concept is based on the knowledge gap hypothesis that predicts that as mass media information infuses the society, higher socioeconomic groups tend to acquire and act based on this knowledge faster than the lower socioeconomic groups, leading to further widening of the knowledge gap (164). A survey conducted in Mexico before the implementation of its pictorial HWLs found that education was the only demographic factor that predicted adults' knowledge of smoking effects (165). Adults with high levels of education (university degree or higher) reported greater levels of health knowledge compared with those with low (primary, middle, or technical/vocational school) or moderate (high school or some university) levels of education. A study conducted in Australia, Canada, US and UK showed that lower socioeconomic status (SES) groups tend to have lower health knowledge about smoking risks, but that countries with pictorial HWLs demonstrated fewer disparities in health knowledge across educational levels (148). Another survey conducted in Australia, Canada, UK and US showed that low SES groups were less likely to have noticed anti-smoking messages on TV and radio and in newspapers and magazines (166). In most countries, smoking is disproportionately concentrated in low SES groups, especially among men (167). Health communications aimed to reduce the smoking burden must attempt to alleviate the disparities in smoking burden.

Pictorial HWLs on cigarette packages are one of the few forms of health communication for tobacco control that are equally likely to reach low SES groups. As the adage says, pictures are worth a thousand words. HWLs are printed directly on the product packaging, leading to broader reach, which results in higher levels of awareness of smoking risks across different SES groups (168). There is growing research suggesting that pictorial HWLs may be more effective in low SES groups (156, 169, 170). An experimental study conducted in Mexico examined the impact of various health warning themes among population subgroups (156). This study found that adults with lower education levels rated graphic HWLs as significantly more effective than adults with higher educational levels. HWLs featuring graphic depictions of disease were rated as most effective by all the sub-groups. Similar findings were found in an experimental study conducted in three regions of South Carolina, US (170). Another experimental study conducted in US compared the effectiveness of pictorial HWLs with text-only labels across racial/ethnic and SES groups (169). This study found that across racial/ethnic groups and SES groups, compared to the text-only labels, pictorial HWLs had greater attention, higher perceived impact, and higher credibility, and increased smokers' intention to quit. The results of experimental studies, however, should be considered in context. In experimental research, participants view a series of warnings for a brief amount of time and then rate them. This does not replicate the real life scenario where a population will be repeatedly exposed to HWLs.

There is limited population-based research that systematically evaluates the effectiveness of HWLs across different SES groups. These studies suggest that HWLs may

be more effective among lower SES groups (171-173). A survey conducted in the EU also found that younger, less-educated, and “Manual worker” respondents were slightly more likely to perceive HWLs as effective in informing them about the health effects of tobacco (171). Another study conducted in EU across four countries, France, Germany, The Netherlands and UK, evaluated the effectiveness of EU text-only HWLs that cover 30% of front and 40% back of the cigarette pack (172). This study showed that HWL effectiveness is greater among low-income smokers compared to high-income smokers in all four countries, and among smokers with low levels of education in all countries except the UK. Another cross-sectional study compared the impact of HWLs in three Latin American countries: Brazil with graphic imagery, Uruguay with abstract pictorial representations of risk and Mexico with text-only messages (173). This study found that smokers with higher education were more likely to notice and read Mexico’s text-only HWLs, while there was no association between education and noticing pictorial HWLs of Brazil and Uruguay. Also, smokers with lower education in Brazil were more likely than smokers with higher education to think about smoking-related risks and quitting due to HWLs. This inverse association of education and impact of HWLs was not present in Mexico, suggesting that compared to text-only warnings, pictorial warning labels do a better job of communicating smoking risks among lower educational groups. The stronger cognitive impact in a lower education group of Brazilian smokers also suggests that the effect of pictorial HWLs wears out more quickly amongst higher education groups (173).

Impact of HWL's across different smoking intensity levels:

There has been very limited research conducted on the impact of HWL's across different smoking intensity levels. Experimental eye-tracking studies conducted to evaluate the effectiveness of plain packaging suggest that non-daily and not-established smokers are more likely to focus their attention towards the HWLs on cigarette packs than daily smokers (174, 175). This increased visual attention towards health information on cigarette packs among non-daily and non-smokers may increase the impact of this information and lead to a reduction in the likelihood of smoking initiation and an increase in the likelihood of smoking cessation among light smokers. Also, compared to daily smokers, non-daily smokers were more likely to report that they would be less tempted to smoke plain packs than regular packs (176). However, experimental studies do not replicate real-life scenarios where populations are repeatedly exposed to HWLs. It is unclear whether smokers become habituated to graphic warning labels, or whether the increased visual attention among non-daily smokers will lead to changes in their smoking behavior.

The limited population-based research conducted to assess the impact of HWLs across different smoking intensity levels also suggests that HWLs have greater impact among non-daily smokers than daily smokers. Using ITC - Canada (2005) and ITC- Mexico (2006) data a study found that smokers with higher levels of nicotine dependence, as measured by the Heaviness of Smoking Index (HSI), were less likely to process the HWLs, have knowledge of health outcomes and intend to quit as a result of HWLs (177). Another cross-sectional study compared the impact of HWLs in three Latin American

countries: Brazil with graphic imagery, Uruguay with abstract pictorial representations of risk and Mexico with text-only messages (173). This study found that compared to daily smokers, non-daily smokers were more likely to report cognitive (thoughts of health risks of smoking, and quitting) and behavioral (forwent a cigarette due to HWLs) impacts due to HWLs, while there were no significant difference in noticing and reading or looking closely at HWLs among non-daily and daily smokers.

Another study using ITC data from four European countries, France, Germany, the Netherlands and the UK, evaluated the effectiveness of European text-only HWLs as measured by the Label Impact Index (172). This study found that smokers who smoke fewer cigarettes per day and smokers who smoked their first cigarette >5 minutes after waking had higher scores of label impact index comprised of key measures of HWL effectiveness suggesting that HWLs have a higher impact among light intensity smokers. So far, studies evaluating the impact of HWLs by smoking intensity levels suggest that HWLs have greater impact among light intensity smokers, i.e., non-daily and less dependent smokers. However, to my knowledge, there have been no studies conducted to evaluate any differential impact of HWL effectiveness across non-daily, daily light and daily heavy smokers. Also, very little is known about whether there is any differential wearout of HWL effectiveness over time across these smoking-intensity groups.

Impact of HWL's over time – "Wearout":

Article 11 of the FCTC covers the use of HWLs to communicate information about the harms of tobacco use (178). The guidelines suggest the following strategies for rotation of HWLs: " *(1) having multiple health warnings and messages appearing*

concurrently or (2) by setting a date after which the health warning and message content will change. Parties should consider using both types of rotation."

Article 11 guidelines imply that the same HWLs will not remain effective over longer periods of time, suggesting that the effectiveness of HWLs will "wearout". This concern of wearout is a well-recognized phenomenon in advertising and communication research. The basic idea of wearout theory is that the response to an advertisement has three stages: in the first stage, an advertisement generates an increasing response as the audience absorbs its message. The second stage is where the response peaks and this is followed by the third stage-a decline (or wearout) as the audience becomes overexposed to the advertisement and less likely to respond (179). Communication research suggests use of more than one advertisement in a strategy of rotation to delay the onset of the third stage of wearout (180).

Research from nationally representative data from Australia, Canada and the UK suggests that HWLs have their greatest impact shortly after initial implementation, and this effectiveness declines over time (9, 10, 155, 181). A study conducted by Hammond et al. in 2007, evaluated the effectiveness of text-only warnings from the US, the UK and Australia and pictorial HWLs from Canada (10). This study found that compared to the US and Australian warnings that were below recommended FCTC standard, more prominent text-only HWLs of UK that were enhanced in 2003 to meet the minimum FCTC standards were associated with greater levels of salience (as measured by noticing and reading HWLs) and greater levels of perceived effectiveness (as measured by HWLs leading smokers to think about quitting and health risks of smoking, and to deter them

from having a cigarette). However, over a period of 2.5 years, the salience and perceived impact declined only in the UK, suggesting the "novelty" effect of HWLs. This decline was greater for salience than the perceived impact measures, suggesting that perceived effectiveness persists longer than the immediate measures of salience. Also, throughout the study period, compared to the UK, though the measures of salience were lower, the measures of perceived effectiveness remained higher in Canada, which has graphic warning labels at the recommended FCTC standard (covering 50% of the front and 50% of back of the pack). In fact, a study conducted by Borland et al., using the same dataset found that the measures of perceived effectiveness, but not warning label salience, have consistent and independent predictive power for making subsequent quit attempts (182). Consistent with the above findings, another study that evaluated the pictorial HWLs of Australia that were implemented in 2006 that were above the recommended FCTC standard (covering 30% front and 90% back of pack) found that implementation was followed by increased salience, cognitive reactions as measured by thoughts of harm and quitting, and behavioral response as measured by forgoing cigarettes and avoiding warnings (155). After controlling for the date of implementation, this study also found that the cognitive reactions and forgoing cigarettes were larger and more sustained in response to Canadian warnings, followed by Australian ones and then the UK ones. These findings suggest that large, more vivid warnings are more effective over time than less prominent warnings.

To overcome HWL wearout, the FCTC Article 11 guidelines suggests two strategies for rotation of HWLs(178): " *(1) having multiple health warnings and*

messages appearing concurrently or (2) by setting a date after which the health warning and message content will change." A study conducted by Hitchman et al examines the effectiveness of first rotation strategy suggested by FCTC, i.e., multiple warnings or messages appearing concurrently for extended periods of time (181). Using 8 waves of ITC data (2002 to 2011), this study compared the effectiveness of pictorial HWLs from Canada implemented in 2001 with 16 different pictorial HWLs covering 50% of front and back of cigarette pack and text-only HWLs of the US implemented in 1984, with one of 4 text warnings covering 8% of pack. This study found that over the 9-year study period, the effectiveness of both the Canadian and US warnings declined statistical significantly over time. The Canadian warnings showed greater decline in effectiveness likely due to its "novelty effect" at introduction just prior to the beginning of the study whereas the U.S. warnings were in place for 17 years at the beginning of the study, i.e., since 1984. However, throughout the study period, Canadian warnings remained significantly more effective for all measures than the US HWLs.

To my knowledge, there have been no studies that systematically evaluated the effectiveness of HWLs over time across various socio-demographic and smoking-related factors. The current HWLs implementation strategy in Mexico provides an excellent opportunity to examine any differential wearout effects of HWLs that are implemented as per the FCTC recommended rotation strategy, i.e., having multiple health warning messages appearing concurrently and health warning content changing periodically.

Context in Mexico:

In 2004, the warning labels in Mexico were increased to 50% of the backside of cigarette packages, with three rotating messages in the warning label area, while the message "Currently there are no cigarettes that reduce health risks" was on the side of every pack. The three warning messages on the back of the pack were: "Smoking causes cancer and emphysema," "Quitting smoking reduces important health risks," and "Smoking during pregnancy increases risk of premature birth and low birth weight babies." The warning text font was not bolded, was relatively small (12 point, normal Helvetica), and there were no warnings on the front of the pack.

In May of 2008, the Mexican President signed the General Tobacco Control Law (GLTC) that included adoption of pictorial HWLs (183). Articles 18 to 22 of GLTC state that the health warnings be placed on 30% of the front (location of the pictogram) and 100% of the side and back (to include the content, emissions, risks and health damage and the telephone helpline for smoking cessation). Similarly, it is forbidden to use the terms "light," "soft" or any other term used to minimize damage. Under these new regulations, the Ministry of Health selects eight new warnings each year and specifies which pair of HWLs the industry must print every 3 months. This rotation frequency is the fastest rotation of HWL content in the world. The implementation period of these new pictorial HWLs began on September 25, 2010. Since then, Mexico has produced four rounds of HWLs. Until September of 2012, every 3 months new pairs of warnings were introduced. From September 2012 to March 2014, warnings were rotated every 6 months. The first set of 8 HWLs were introduced in 2010, the second set of 8 HWLs in

2011, the third set of 4 HWLs in 2012, the fourth set of 8 HWLs in 2013 and a fifth set of 4 HWLs in 2014.

Summary of background:

To increase smokers' knowledge of the health risks of smoking, WHO FCTC recommends that countries ratifying the treaty implement HWLs on cigarette packs (1). Research has shown that large pictorial HWLs are effective in increasing the health knowledge of smoking, increasing smoker's motivation to quit and increasing their likelihood to remain abstinent following a quit attempt (9-17). Also, experimental studies have shown that, compared to text-only warning, large pictorial HWLs and HWLs with graphic depiction of diseased organs were rated as the most effective by all ethnic/racial and SES groups (156, 169, 170). Similarly, the population-based studies also showed that compared to higher educational groups, the lower educational groups reported pictorial HWLs as more effective in making them think about smoking-related risks and quitting due to HWLs (172, 173). Also research shows that non-daily smokers were more likely than daily smokers to report cognitive and behavioral responses to HWLs (172, 173). The FCTC Article 11 guidelines suggest rotating the HWLs to avoid the potential wearout of HWLs.

The objective of this paper is to study if Mexico's HWLs on cigarette packages are subject to a similar decline in effectiveness over time as found in other communications research. The few studies that looked at the wearout of HWLs over time were conducted in HICs and looked at HWL responses at longer follow-up periods, mostly over a year. To my knowledge, there have been no studies conducted in the LMICs that

have evaluated the effectiveness of HWLs over time. This study will be the first to assess the correlates of HWL wearout. Also, Mexico has the world's fastest rotating HWL schedule. The short follow-up period, 4-month interval, in the present study helps to address the habituation to HWLs and also to rule out the influence of any intervening variables. The following conceptual model is adopted from the ITC conceptual model for evaluating the tobacco control policies under FCTC treaty (139). As illustrated, this model hypothesizes that HWLs influences individual behaviors first by influencing the factors that are most proximal to the policy itself such as HWL salience - noticing and reading HWLs, and forgoing a cigarettes which as a result influence the psychosocial mediators such as thinking about the harms of smoking and quitting smoking leading to intending to quit, attempt to quit and eventually stop smoking altogether. The moderator variables are of interest to determine if the policy has any differential effect across the population subgroups.

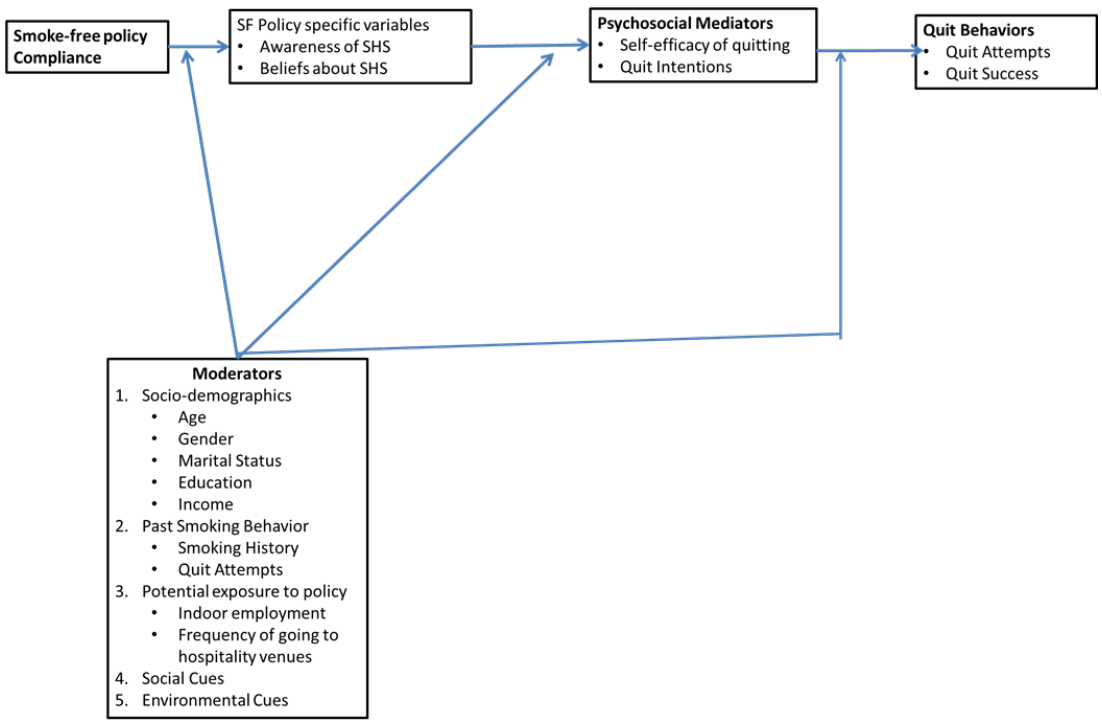


Figure 2.1: Conceptual model illustrating the hypothesized model for how smoke-free policy influences individual smoking behavior

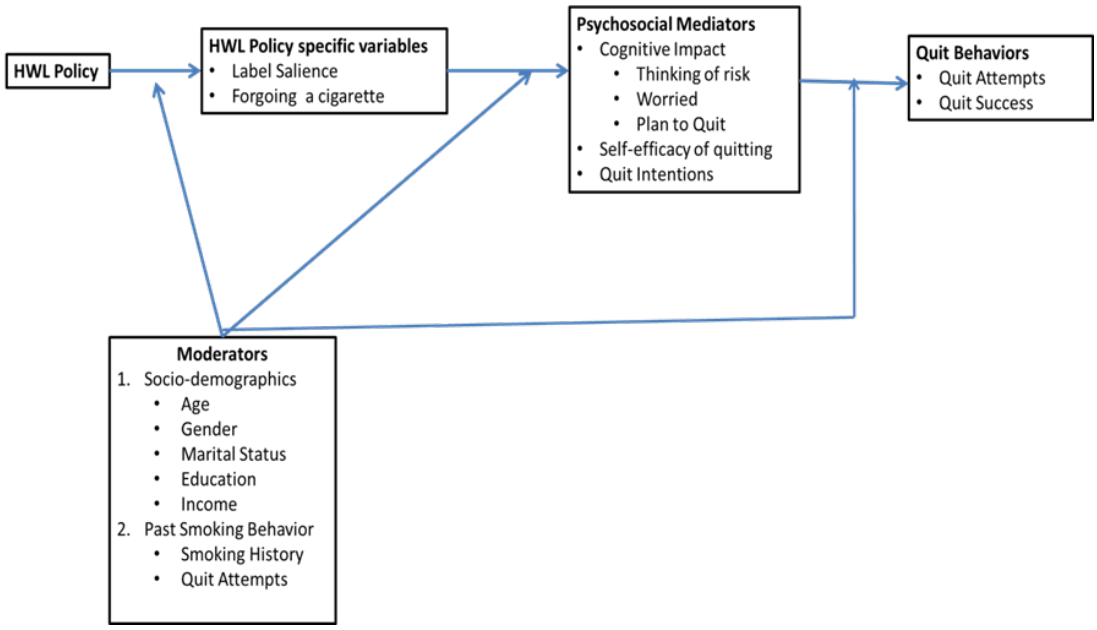


Figure 2.2: Conceptual model illustrating the hypothesized model of how HWLs influence individual smoking behaviors.

CHAPTER 3

Factors associated with changing cigarette consumption patterns among low-intensity smokers: Results from ITC-Mexico survey

3.1: INTRODUCTION:

Over the past decade, smoking prevalence has substantially reduced in several high-income countries (HICs) (27, 65, 184-186). However, the prevalence of light smoking (less than 10 cigarettes per day (CPD)) and intermittent smoking (non-daily (ND)) has increased significantly, suggesting a shift in smoking behavior to lower consumption patterns (65, 184, 185). For example, the adult smoking prevalence in New York City decreased by 28% from 2002-2012(184). The prevalence of smokers who consumed more than 10 CPD decreased from 52% to 38%, but the prevalence of ND smoking increased from 32% to 39% (184). While light and intermittent smoking patterns are an emerging phenomenon in high-income countries, population-based surveys have consistently shown that these patterns are highly prevalent and even dominant in many low- and middle-income countries (LMICs). In countries such as Ecuador, Guatemala, Costa Rica, and Iraq about two-thirds of smokers are ND (1). Mexico, a middle-income country, has a smoking pattern that contrasts to patterns in

HICs. About two-thirds (64%) of Mexican smokers are either ND smokers or daily smokers who consume <= 5 CPD, and daily smokers smoke 9.4 CPD on average compared to 14.6 CPD in the US (5, 28). This pattern of smoking appears to have been established for at least two decades (187).

Light and intermittent smokers (LITS) also possess substantial health risks (47). Compared to non-smokers, LITS have increased risk for cancer, myocardial infarction, and cardiovascular mortality (41-46). These health implications underscore the importance of including this particular group of smokers in research studies and understanding the patterns and natural history of LITS. We know little about how light and intermittent smoking develops over an individual's smoking history or how smokers move from light and intermittent smoking to heavy smoking levels or to quitting. Though LITS are at greater risk for negative health outcomes than non-smokers, there is evidence that heavy smokers who substantially reduce their consumption level and remain smoking at very low levels have decreased mortality risk compared to heavy smokers who continue to smoke at similar rates (48). It is important to understand the characteristics of smokers who reduce their consumption intensity and maintain smoking at low levels so as to develop and tailor the cessation interventions for each of the particular group.

The majority of studies about smoking transitions among adult smokers are of limited utility for understanding light and intermittent smoking patterns. These studies either did not distinguish between daily-light (DL) smokers and daily-heavy (DH) smokers (34, 58-60), used retrospective study designs to assess baseline smoking status

(34), or studied very specific population groups (e.g., older population (59) or working population (58)). All these studies were conducted in HICs. Among the studies that differentiated between ND, DL and DH smoking groups (63-67), the cut points used to distinguish DL and DH smoking were not consistent (<10 CPD (63, 65) vs <= 5 CPD (64, 66, 67) as DL smoking). Studies that did distinguish between ND and DL smoking groups showed that the natural history of DL smoking to be very fluid, while ND smoking was a more stable group (63-67). Despite exhibiting lower nicotine dependence, ND smokers were no more likely to attempt to quit than DH smokers (64, 66, 67), but they were more likely to successfully quit at the follow-up periods compared to DL and DH smokers (63-67). To our knowledge, there has been only one study that looked at the predictors of these smoking transitions, which was conducted in the US (66). This study showed that among very light (<= 5 CPD) smokers, not smoking daily, smoking mostly with friends, planning to quit in the next 30 days, and living in homes with smoking bans were all independent predictors of quitting over a 2-year follow-up period. Among very light smokers, being White, smoking daily, being highly nicotine dependent, and being in the company of smoking friends were all predictive of transitioning to heavy smoking levels at the 2-year follow-up. DH smokers (6-10 CPD) who had higher self-efficacy in quitting, and who made a 24-hour quit attempt in the past year were more likely to either maintain or reduce consumption than to increase it. The majority of smokers in this study were Whites from the US who historically had higher smoking intensities than ethnic minority groups such as Latinos and Asians (188).

Though these results provide some insight into the differences between LITS and heavy smokers, they may not be generalized to smokers in LMICs. In the case of Mexico, Mexican smokers generally have lower smoking intensity than smokers in HICs (1), and the tobacco policy environment and social and cultural norms around smoking differ from HICs. Mexico ratified the World Health Organization's (WHO) Framework Convention on Tobacco Control (FCTC) in 2004, and subsequently implemented a wide range of tobacco control policies. The light and intermittent patterns of smoking observed in Mexico appear to have been established even before strengthening the tobacco control environment in Mexico (187).

Previous research suggests that following the implementation of such policies, the smoking prevalence in a society reduces leaving behind a group of "hardcore" smokers who are highly addicted and find it difficult to quit(189, 190). This idea is often referred as "hardening hypothesis" (189, 190). From a public health perspective, it is important to understand which groups of smokers are quitting, and which smoking groups are escalating to higher intensity levels. This understanding will help target public health interventions to appropriate groups. Additionally, to the best of our knowledge, there have been no studies of changes in smoking patterns over time in LMICs where LITS are the dominant smoking patterns.

To address these research gaps, using data from the Mexican administration of the International Tobacco Control Policy Evaluation Survey (ITC-Mexico) waves III – VI, we aim to 1) investigate the changes in cigarette consumption patterns of ND, DL and DH smokers over a four-year period with a maximum of three follow-up surveys after

baseline, and 2) identify factors that are associated with progression to either a) heavier smoking levels among ND and DL smokers or b) reduction or quitting among ND, DL and DH smokers. First, we hypothesize that, over time, Mexican ND and DL smokers are more likely to reduce their cigarette consumption than to escalate to heavy smoking levels, and Mexican DH smokers are more likely to maintain the same intensity level than to reduce their consumption. Second, we hypothesize that the quit behavior among DH smokers is primarily influenced by their perceived addiction and social norms may not influence changes in cigarette consumption at the follow-up for this group of smokers while the quit behavior among ND and DL smokers is influenced by social norms, i.e., weaker descriptive norms (i.e., having a smoking partner/spouse, more smokers among the five closest friends), stronger subjective norms (i.e., perception of what important people think about their smoking) and anti-smoking societal norms influence reduction or quitting among ND and DL smokers while measures of addiction influence quitting or reduction among DH smokers.

3.2: METHODS:

Study Setting and Population:

The International Tobacco Control Policy Evaluation Project (ITC) is an international effort to understand tobacco policy impacts among population-based, representative cohorts of adult smokers in more than 20 countries. The Mexican administration of the ITC project started in 2006, and six waves of data were collected up until 2012.

In the first wave of data collection, four major cities were sampled. In wave III, three other cities were included, and starting in wave IV one of the original four cities was

replaced by a different city because of difficulties with data collection (i.e., concerns for interviewer safety). Within the selected cities, stratified, multi-stage sampling was used. Census tracts and then block groups were selected with probability proportional to the number of households according to the 2000 or 2005 census (used for the first four cities and the more recently introduced cities, respectively). Within blocks, a random sample of smokers was selected, and face-to-face interviews were conducted. To maintain the sample size across waves, samples were replenished with adult smokers from already selected census tracts or randomly selected census tracts that were adjacent to the originally selected tracts.

In this study, data collected from the seven cities that participated in waves III, IV, V and VI were analyzed (Guadalajara, Léon, Mérida, Mexico City, Monterey, Puebla and Tijuana). Wave III was administered in November–December of 2008, wave IV in January–February of 2010, wave V in April–May 2011, and wave VI in October–December 2012. Participants with at least one consecutive wave of follow-up were included in the analysis.

Measurements:

Smoking Intensity:

Smoking intensity was determined by asking participants at each wave to report daily or ND smoking, as well as the average number of cigarettes they smoked on the days that they smoked. Based on the response to these questions, smoking intensity was classified as: ND, DL (daily smoking <= 5 CPD), and DH (daily smoking > 5 CPD) smokers. These categories generally reflect tertiles of consumption intensity in Mexico, and are

also informed by previous research that has considered the low level of smoking among Latinos (29). Also, separating DL smokers from other daily smokers allows for a detailed examination of potential differences in factors associated with smoking transitions for this particularly understudied group of adult smokers.

Quit behavior:

At the follow-up, people who indicated that they had quit were asked how long ago they had quit. Participants who had quit for more than 30 days were coded as quitters, as suggested by previous research (19). People who continued to smoke at the follow-up were asked if they had attempted to quit in between the waves. Participants that responded affirmatively were coded as having made an attempt to quit in between waves. Quit intentions were assessed by asking whether participants planned to quit in the next month, in the next six months, sometime beyond six months, or not at all, with responses dichotomized to indicate intention to quit within the next six months versus no.

Socio-demographic variables:

Socio-demographic variables include self-reported age (18 – 24 years, 25 – 39 years, 40 – 54 years, 55 years and older); gender (male and female); marital status (married or in a partnership, single and other); educational attainment (less than middle school, middle school, technical/vocational course, high school, University graduate); and household income (0 – 3000, 3001 – 5000, 5001 – 8000, more than 8001 pesos per month).

Other covariates:

Measures of Addiction: Participants were asked the age when they smoked their first cigarette, with responses dichotomized at the sample median value as <= 16 years and > 16 years. Perceived addiction to cigarettes was ascertained by asking the participants "Do you consider yourself addicted to cigarettes?" Response options included "Yes, very much;" "Yes, but not much;" "No;" and "don't know," which was recoded to missing. Although common measures of nicotine dependence are Fagerstrom Test of Nicotine Dependence (FTND) scores or the Heaviness of smoking index (HSI), we used perceived addiction as a proxy measure of nicotine dependence given the highly skewed distribution of HSI among Mexican smokers. Perceived addiction has been shown to be an important predictor of smoking susceptibility among youth (191, 192) and an important predictor of quit behavior among Mexican smokers (18).

Social norms: Socially embedded norms around smoking can be one important pathway by which smokers change their smoking behaviors (193, 194). Three markers of social norms were measured in this study: descriptive norms, subjective norms and anti-smoking societal norms. Descriptive norms were ascertained by asking participants "Of the five closest friends or acquaintances that you spend time with on a regular basis, how many of them are smokers?" The responses were recoded as "none," "1 to 3," and "4 or 5" to keep the no smoking friends separate and to have equal distribution in the upper two categories. Spouse / partner smoking status was ascertained by asking participants first whether they currently live with a partner or spouse, followed by a

question about spouse / partner smoking status for those who live with a partner / spouse. Responses were recoded as “smoking spouse/partner,” “not smoking spouse/partner,” and “no partner.” Subjective norms are “the expectation of significant others that one should adopt a specific behavior” (194). This was ascertained by asking smokers their response on a Likert scale for the following statement: “People who are important to you believe that you should not smoke.” Response options were recoded as agree/strongly agree versus all other responses. The anti-smoking societal norms variable was created by combining three items that assess smoker’s perception of social norms against smoking at a more general, societal level: “There are fewer and fewer places where you feel comfortable smoking,” “Mexican society disapproves of smoking,” and “People who smoke are more and more marginalized.” Response options for these three items were on a five-point Likert scale ranging from strongly disagree to strongly agree. The average of these three items was used to measure anti-smoking societal norm ranging from 1 to 5. The internal consistency for this scale was reasonable (Cronbach’s alpha = 0.62). These items were used in previous studies to measure anti-smoking societal norms (109, 195) and the societal norms have been shown to be independent predictors of smoking cessation (109).

Statistical Analysis:

All analyses were performed in Stata V.13. Given that the aims of this study were to examine smoking transitions at t+1 and t+2 (i.e., first and second follow-up periods) conditional upon the smoking status at time t, all analyses were stratified by smoking status at time t. The complex survey design and weighting were adjusted for when

conducting the analyses. Bivariate analysis was conducted to examine differences in covariates of interest across the three smoking categories: ND, DL and DH. Chi-square tests were conducted to assess any differences at the α=0.05 level. The conditional probabilities of each of the possible smoking transition categories(i.e., quitting, or increase/reduce smoking consumption, or continue smoking at the same level) over each of the two consecutive follow-ups with 95% confidence intervals (CI) were estimated. That is, we calculated the percentage of smokers in each smoking category at t+1, conditional on their smoking status at t, and then the percentage of participants in each smoking category at t+2 conditional on their combined smoking pattern at t and t+1. We conducted survey-based logistic regression analyses to assess (a) the likelihood of quitting smoking at t+1 as a function of smoking status at t, (b) the likelihood of quitting at t+2 as a function of a function of whether the person increased/decreased smoking or remained stable at t+1, and (c) the likelihood of being stable across the two follow-up periods as a function of smoking status at t. P-values were provided in describing the aforementioned differences.

To identify the factors associated with smoking transitions at the follow-up wave, we pooled observations from all possible waves of follow-up treating data from each wave as a separate observation while adjusting for the non-independence of observations on individual smokers using the cluster command in the svyset procedure. We ran a series of models to examine the relationship between the three blocks of independent variables of interest (i.e., measures of addiction, measures of social norms, and measures of quit behavior) and smoking transitions at the successive follow-up

wave, stratified by smoking status at the present wave, treated as baseline for a the present wave. The first model measured the bivariate association of each of the variables in the three blocks of independent variables and the smoking transition at the successive follow-up period. The second model was an adjusted model that included each of the variables in the three blocks of independent variables, socio-demographic variables, the wave of participation and time in the sample. The third model was a fully adjusted model that included all the variables in each block of independent variables along with the socio-demographic variables, the wave of participation and time in the sample. The outcomes of interest in each model were in relation to the baseline smoking status. That is, for ND smokers: quitting, increasing consumption, or remaining stable; for DL smokers: quitting/reducing, increasing consumption, or remaining stable; and for DH smokers: quitting/reducing or remaining stable. For baseline ND and DL smokers survey-based multinomial logistic regression models were run, and for baseline DH smokers, survey-based logistic regression models were run.

3.3: RESULTS:

Characteristics of smokers by level of cigarette consumption

Table 1 shows the baseline characteristics of the cohort of smokers by the three smoking status categories. Statistically significant differences were observed between ND, DL and DH smokers for socio-demographics, quit behavior, measures of addiction, and partner smoking status. For example, compared to DH smokers, ND smokers appear to be more likely to be of younger age, married or single, intending to quit in next six-months, to have attempted to quit in previous year, to report not at all addicted to

smoking and less likely to have initiated smoking by 16 years of age. There were no significant differences across the three smoking status categories for the number of smokers among the participants' five closest friends, subjective norms, societal norms, wave of participation and time in sample.

Smoking transitions across the two follow-up periods

Figures 1, 2, & 3 present a set of estimated transition probabilities showing the movement between smoking status categories from one wave of interview to the next, with a maximum of three consecutive interviews for the baseline ND, DL and DH smokers, respectively. Because the data are weighted, the product of conditional probabilities from t to t+2 does not exactly reflect the percentage of smokers following the same path.

Compared to DL and DH smokers, ND smokers were more likely to quit from time t to t+1 (ND_{prob} = 25%, 95% CI 21% - 29%; DL_{prob} = 14%, 95% CI 11% - 18%; DH_{prob} = 9%, 95% CI 6% - 12%; $p<0.001$). All smokers who reported having quit at t+1 have more than 60% probability of staying quit at t+2 (ND_{prob} = 74%, 95% CI 62% - 83%; DL_{prob} = 66%, 95% CI 53% - 77%; DH_{prob} = 61%, 95% CI: 42% - 78%). Also, ND smokers had a higher probability of staying quit across the two follow-up periods, compared to DL and DH smokers at time t (ND_{prob} = 13%, 95% CI 10% - 17%; $p<0.01$; DL_{prob} = 8%, 95% CI 6% - 11%; DH_{prob} = 4%, 95% CI 2% - 6%). Across allthree time periods, DL smoking is the least stable smoking pattern for Mexican smokers (DL_{prob} = 16%, 95% CI 12% - 20%; DH_{prob} = 29%, 95% CI 24% - 34%; ND_{prob} = 23%, 95% CI 19% - 28%; $p<0.01$). DH smoking is the most stable group with about 60% of smokers remaining DH from t to t+1, and about

one-third of DH smokers remaining in the same category across the three consecutive interviews.

Continuing ND smokers (those reported being ND smoker at time t and t+1) had a greater probability of maintaining the ND smoking status at time t+2 (61%, 95% CI 52% - 70%) or successfully quitting at t+2 (20%, 95% CI 14% - 26%) than increasing smoking consumption to DH smoking at time t+2 (7%, 95% CI 4% - 13%). Continuing DL smokers (those reported being DL smoker at time t and t+1) had a probability of 49% (95% CI: 40% - 59%) of maintaining DL smoking status at t+2. A DL smoker at time t who transitioned to ND smoking at t+1 was more likely to continue smoking at the same level at t+2 (43%, 95% CI 32%-55%) than to increase consumption to DH smoking status (11%, 95% CI 5%-22%). Continuing DH smokers (those reported being DH smoker at time t and t+1) had greater probability of maintaining the DH smoking status at time t+2 (61%, 95% CI 53% - 68%) or reducing to DL smoking at t+2 (24%, 95% CI 18% - 31%) than of successfully quitting (4%, 95% CI 2% - 8%) or becoming a ND smoker by t+2 (10%, 95% CI 6% - 16%).Also, a DH smoker at time t had a higher probability of being quit at t+2 (15%, 95% CI 7% - 29%) if his/her smoking consumption was reduced to ND at t+1 than if he/she continued to be DH (4% 95% CI 2% - 8%) ($p<0.01$).

Factors associated with smoking transition at the follow-up period

Tables 2, 3 and 4 present results from bivariate and multivariable logistic regression analyses conducted to identify the factors associated with smoking transitions at the successive follow-up period.

Baseline non-daily smokers

Table 2 presents the association between the three blocks of variables (i.e., measures of addiction, measures of social norms, measures of quit behavior) and smoking status at the follow-up period among baseline ND smokers. Compared to ND smokers who initiated smoking after the age of 16 years, initiating smoking at 16 years or younger age was not associated with either successful quitting or increasing smoking consumption by the follow-up period in either bivariate or adjusted models. Compared to ND smokers who reported no addiction to smoking, ND smokers who reported little or high levels of addiction to smoking were less likely to have quit by the follow-up period ($OR_{\text{Little vs not at all in fully adjusted model}}$ = 0.6, 95% CI 0.4 – 0.91 &$OR_{\text{very much vs not at all in fully adjusted model}}$ = 0.34, 95% CI 0.14 – 0.83) and also more likely to have increased consumption by the follow-up period ($OR_{\text{Little vs not at all in fully adjusted model}}$ = 1.64, 95% CI 1.11 – 2.42 &$OR_{\text{very much vs not at all in fully adjusted model}}$ = 1.94, 95% CI 1.06 – 3.55).

ND smokers who had a non-smoking partner / spouse or who did not have a partner / spouse were more likely to have quit by the follow-up period than to stay stable, compared to ND smokers who had a smoking partner / spouse ($OR_{\text{no smoking partner vs smoking partner in fully adjusted model}}$ = 1.63, 95% CI 1.01 – 2.61 & $OR_{\text{no partner vs smoking partner fully adjusted model}}$ = 2.03, 95% CI 1.25 – 3.3). ND smokers with strong subjective norms (i.e., perception of what important people in their life think about their smoking) were less likely to increase their smoking consumption at the follow-up period than to stay stable, compared to ND smokers who did not strongly agree with the question ($OR_{\text{agree vs not agree in fully adjusted model}}$ = 0.63, 95% CI 0.42 – 0.95). Neither the number of smokers among the

five closest friends nor anti-smoking societal norms was associated with successful quitting or increasing consumption by the follow-up period in either bivariate or adjusted models.

Attempting to quit at least once in the previous year was associated with a higher odds of having quit by the follow-up period, compared to not attempting to quit ($OR_{\text{fully adjusted model}}$ = 1.53, 95% CI 1.025 – 2.27). Intending to quit in the next 6 months was associated with a lower odds of increasing consumption by the follow-up period, compared to not intending to quit ($OR_{\text{SD adjusted model}}$ = 0.65, 95% CI 0.44 – 0.97). This association did not achieve statistical significance in the fully adjusted model ($OR_{\text{Fully adjusted model}}$ = 0.65, 95% CI 0.42 – 1.004).

Baseline daily-light smokers

Table 3 presents the association between the three blocks of variables (i.e., measures of addiction, measures of social norms, measures of quit behavior) and smoking status at the follow-up period among baseline DL smokers. Compared to DL smokers who initiated smoking after the age of 16 years, initiating smoking at age 16 years or younger was not associated with either successful quitting/reducing smoking consumption or increasing smoking consumption by the follow-up period in either bivariate or adjusted models. Compared to DL smokers who reported no addiction to smoking, DL smokers who reported little or high levels of addiction to smoking were less likely to have quit/reduced cigarette consumption by the follow-up period ($OR_{\text{Little vs not at all in fully adjusted model}}$ = 0.6, 95% CI 0.41 – 0.87 &$OR_{\text{very much vs not at all in fully adjusted model}}$ = 0.39, 95% CI 0.25 – 0.62) and DL smokers who reported high levels of addiction were more

likely to have increased consumption by the follow-up period ($OR_{\text{very much vs not at all in fully adjusted model}}$ = 2.02, 95% CI 1.17 – 3.48).

Neither the descriptive norms (i.e., partner/spouse smoking status and number of smokers among five closest friends) nor the subjective norms predicted successful quitting/reducing smoking consumption or increasing consumption by the follow-up period in either bivariate or adjusted models. However, stronger anti-smoking societal norms was associated with lower odds of increasing smoking consumption by the follow-up period ($OR_{\text{fully adjusted model}}$= 0.73, 95% CI 0.58 – 0.91).

Compared to DL smokers who have not attempted to quit in previous year, DL smokers who attempted to quit at least once in the previous year were more likely to have quit/reduce cigarette consumption by the follow-up period and less likely to have increased consumption by the follow-up period, ($OR_{\text{SD adjusted model}}$ = 1.41, 95% CI 1.01 – 1.97 & $OR_{\text{SD adjusted model}}$ = 0.63, 95% CI 0.42 – 0.94 respectively). Intending to quit in the next 6 months was associated with a higher odds of quitting/reducing cigarette consumption by the follow-up period, compared to not intending to quit ($OR_{\text{SD adjusted model}}$ = 1.9, 95% CI 1.24 – 2.91). These associations were slightly attenuated in the fully adjusted model (for quit attempts: $OR_{\text{fully adjusted model}}$ = 1.31, 95% CI 0.94 – 1.82 &$OR_{\text{fully adjusted model}}$ = 0.62, 95% CI 0.41 – 0.94 respectively; for quit intentions: $OR_{\text{fully adjusted model}}$ = 1.8, 95% CI 1.18 – 2.73).

Baseline daily-heavy smokers

Table 4 presents the association between the three blocks of variables (i.e., measures of addiction, measures of social norms, measures of quit behavior) and

smoking status at the follow-up period among baseline DH smokers. Compared to DH smokers who initiated smoking after the age of 16 years, initiating smoking at 16 years or younger was not associated with successful quitting/reducing smoking consumption than being stable by the follow-up period in either bivariate or adjusted models. Compared to DH smokers who reported to have no addiction to smoking , DH smokers who reported high level of addiction to smoking were less likely to have quit/reduced cigarette consumption by the follow-up period ($OR_{\text{very much vs not at all in fully adjusted model}}$ = 0.47, 95% CI 0.26 – 0.85).

In the bivariate model, DH smokers who did not have a partner / spouse were more likely to have quit/reduce cigarette consumption by the follow-up period than to stay stable, compared to DH smokers who had a smoking partner / spouse ($OR_{\text{no partner vs smoking partner bivariate model}}$ = 1.55, 95% CI 1.08 – 2.24). This association did not achieve statistical significance in fully adjusted model ($OR_{\text{no partner vs smoking partner fully adjusted model}}$ = 1.85, 95% CI 0.99 – 3.46). In both bivariate and adjusted models, the number of smokers among the five closest friends, subjective norms and anti-smoking societal norms were not associated with successful quitting/reducing cigarette consumption by the follow-up period.

Compared to DH smokers who did not attempt to quit in the previous year, DH smokers who attempted to quit in previous year were no more likely to have quit/reduce their cigarette consumption by the follow-up period than to stay stable ($OR_{\text{fully adjusted model}}$ = 0.91, 95% CI 0.65 – 1.27). Intending to quit in next 6 months was associated with a higher odds of quitting/reducing cigarette consumption by the follow-

up period, compared to not intending to quit ($OR_{fully\ adjusted\ model}$ = 1.59, 95% CI 1.04 – 2.41).

3.4: DISCUSSION:

The results from this study suggest that compared to DH smokers, ND and DL Mexican smokers exhibited less stable smoking pattern. Among the three smoking groups at time t, ND smokers were more likely to achieve abstinence at t+1 and t+2, and DL smokers were equally likely to reduce or increase their smoking consumption at the follow-up period. For all three smoking groups, perceived addiction was consistently an important factor associated with quitting/reducing or increasing cigarette consumption at the successive follow-up. Only for a ND smoker not having a smoking spouse/partner was associated with quitting at the follow-up and the subjective norms i.e., perception of what important people in their lives think about their smoking, were associated with increasing cigarette consumption at the follow-up. For a DL smoker, stronger anti-smoking societal norms were associated with not increasing the cigarette consumption by the follow-up period. For both ND and DL smokers quit attempt made in the past year was statistical significantly associated with changing cigarette consumption at the follow-up while only for DL and DH smokers intending to quit in next 6 months was associated with quitting/reducing consumption at the follow-up.

Over the two follow-up periods, quitting smoking and being stable were the two most common outcomes for ND smokers compared to increasing cigarette consumption. Despite not smoking every day, about a quarter of ND smokers at time t continued to smoke at the same levels These findings are consistent with longitudinal

studies conducted on LITS from the US (58, 59, 64, 66, 67). Also, considerable proportion of baseline DL and DH smokers (i.e., 26% of initial DL smokers and 13% of initial DH smokers) reduced their consumption to ND status. This finding is consistent with recent studies from the US that showed ND smokers as a mixed population of continuous ND smokers, as well as smokers who have transitioned from daily smoking to ND but may have difficulty in achieving abstinence (22, 60). Future research is needed to identify ideal strategies that could help these smokers quit completely. Most of the available evidence on the cessation interventions is based on smokers with relatively high daily consumption (196).

DL smokers at time t were more likely to either increase their consumption to DH level or to reduce to ND than to quit at t+1. However, once they converted to ND smokers at t+1, they were less likely to increase their consumption to DH levels at t+2 than to maintain at ND status. DH smokers at time t who cut down their smoking consumption to ND status may increase their future likelihood of quitting cessation. We are not sure whether this reduction in smoking is a deliberate step for eventual quitting. However, previous research shows that smokers who quit cold turkey were more likely to be smoke-free for more than 30 days than those who gradually cut down to quit (60, 62). Nevertheless, this is an important finding in our study given the building evidence about the decreased mortality risk associated with reducing smoking consumption (48).

For all three smoking groups, perceived addiction appears to play an important role in changing cigarette consumption in the future. Smokers who perceived themselves as addicted were less likely to quit/reduce smoking consumption at the

follow-up compared to smokers in their group who perceived themselves as not at all addicted. Also, ND and DL smokers who perceived themselves as addicted were more likely to increase their consumption at the follow-up compared to the smokers who perceived themselves as not addict. These results suggest that the majority of smokers who continued to smoke during the study period were smokers who perceived themselves as addicted. This finding is suggestive of possible "hardening" among the Mexican smokers as well and these results are in line with a study that supports the hardening hypothesis by comparing the prevalence of smoking in different countries with the subsequent level of nicotine dependence as measured by FTND score (197). The multi-country study found that lower smoking prevalence was associated with higher scores of nicotine dependence, suggesting higher cessation activity among low-dependent smokers. Previous studies among youth and adolescents also found that perceived addiction was an important predictor of susceptibility to smoking (191, 192). Given that LITS are less likely to receive any cessation advice at a doctor's office (18), perceived addiction could be used as an important measure in clinical settings for referral to cessation services for LITS.

Another important finding of this study was that social norms were mostly not associated with changes in smoking consumption for baseline DL and DH smokers. However, among baseline ND smokers, compared to smokers with smoking partner/spouse, not having a smoking partner/spouse was associated with higher likelihood of quitting than remaining stable. Also, compared to baseline ND smokers who did not have strong subjective norms against smoking (i.e., perception of what

important people in their life think about their smoking), ND smokers who had strong subjective norms against smoking were less likely to increase their cigarette consumption than to remain stable. This finding among baseline ND smokers supports the findings from a study conducted in the US (33). Comparing Latinos to Whites, the study found that that Latinos were more likely to smoke due to social and environmental cues and family, and interpersonal relations were important reasons for Latinos to quit (33). Another study conducted in the US looked at smoking behaviors in large social networks and found that among all social contacts, a spouse's smoking status had greater impact on a person's smoking status(198). Another study that examined the impact of six social influence variables on smoking cessation found subjective norms against smoking to be the most important factor influencing smoking cessation (194). Even though there were very few differences among the three groups of smokers at baseline for descriptive and subjective norms against smoking, we did not find any association between these norms and changing smoking behaviors for the DL and DH smokers. Research shows that the correlation between subjective norms and changing a behavior is much weaker than the correlation between perceived behavioral control (i.e., perception of addiction)and changing a behavior (199). Hence, the lack of association between subjective norms and quit behavior among DL and DH smokers might indicate that their quit behavior was primarily influenced by personal factors such as perceived addiction. Policies or interventions that change norms might have greater impact in bringing about changes in smoking for ND smokers.

It is beyond the scope of the present study to investigate why Mexican smokers smoke at such low intensities. However, LITS patterns found in Mexican and Central American countries are also reflected among Latinos in the US. Latinos were over three times more likely to smoke intermittently and over four and half times more likely to smoke fewer than five CPD compared to Whites (30). Among Hispanic / Latinos, light and intermittent smokers were typically from Mexican and Central American origins (35, 36). Studies conducted in the US show that compared to Non-Hispanic Whites, Latinos from the US reported lower addiction and had lower serum cotinine levels, but the nicotine metabolism rates were not different (200-202). There could be other genetic factors or gene-environment interactions that might be operating differently among smokers of Mexican heritage. Also, the social, environmental and cultural factors among Latinos might be responsible for such low consumption rates. Another study conducted among young Latino adults in the US found that foreign-born, first generation Latinos have stronger descriptive and subjective norms about smoking, and that these adults were less likely to be current smokers (203). Also, foreign-born Latinos were more accepting of smoking bans than their US-born counterparts (204). These findings, along with the important influence of social norms in changing smoking consumption behavior that we found in our study lend support to the notion that tobacco control policies and cessation interventions that change norms regarding the acceptability of smoking might be playing a bigger role in promoting quitting and reducing consumption among Latinos. In fact, following the implementation of Mexico-City's smoke-free policies, anti-smoking societal norms became stronger (96).

Limitations

Our study results should be interpreted in light of a few limitations. Our data only covers a limited period of the entire smoking history for these smokers. We only assessed smoking status as reported at the time of interview. There could be unobserved changes in smoking status between study time points. Also, there could be several other factors, such as policy implementation or neighborhood level factors, that might influence the changes in smoking consumption patterns over time. This study was conducted during the time of rapid implementation of several of the FCTC-recommended tobacco control policies. Hence our results may not reflect the changes in cigarette consumption outside the policy implementation.

Across the three smoking groups at time t, about one-fourth of the sample in each group was lost to follow-up at t+2, reducing our sample size for t+1 to t+2 analysis. Because of this limited sample size, many of our smoking transition estimates from t+1 to t+2 have wide CIs. This loss to follow-up could have introduced selection bias. Across the three smoking groups, smokers who were not lost to follow-up at t+2 were more likely to have reported the same smoking status at t and t+1 compared to smokers who were lost to follow-up at t+2. Hence we may have underestimated the proportion of smokers who made a transition from t+1 to t+2. However, for perceived addiction, social norms measures and quit intentions, those who were lost to follow-up were not statistical significantly different from the smokers who were followed-up from t+1 to t+2, suggesting that the influence of attrition may be minimal in the analysis looking at the factors associated with smoking transitions.

All the measures used in this study were self-reported and might potentially be prone to social desirability bias that might have resulted in the overestimation of social norms and underestimation of smoking intensity levels. We did not conduct biochemical verification of smoking abstinence. However, our results about smoking intensity are in general consistent with those that have been found in other population-based surveys in Mexico (5, 187). Previous research involving an earlier survey administration in this study cohort also found reasonable correlation between self-reported consumption level and saliva cotinine levels (205). Also, the number of smoking friends question was asked about close friends/acquaintances. Cognitive testing work suggests that some smokers consider family members while answering this question (206). In that case, there could be a potential information bias in understanding the question and this measure may not be reflective of only friends smoking status. But we do not believe that this bias is related to the baseline smoking status or the changes in smoking pattern. Lastly, the generalizability of these findings might be limited by the fact that this study was conducted in seven of the major cities in Mexico and did not include rural areas. However, these seven cities include all major regions of the country, and about 78% of Mexicans live in urban areas (207).

To the best of our knowledge, this is the first study in LMICs to examine the changes in smoking consumption patterns and the factors that are associated with these changes. By stratifying analyses by smoking status, we were able to identify the factors that were associated with quitting/reducing smoking or increasing consumption among ND, DL and DH smokers. Our study found that compared to DH and DL smokers, ND

smokers were more likely to quit at the follow-up, DH smoking was the most stable group and a DH smokers who reduced their cigarette consumption to ND were more likely to quit eventually than a DH smoker who continued to smoke at the same level. For all three smoking groups, perceived addiction and either previous quit attempts or intentions to quit in the future were statistically significant predictors of changing cigarette consumption at the follow-up. Only for ND smokers, spouse/partner smoking status and subjective norms about smoking were associated with changing cigarette consumptions at the follow-up. Social norms in general were not associated with changes in cigarette consumption for DL and DH smokers. Future research should aim to investigate whether there is any differential impact of tobacco control policies, programs and interventions across different smoking intensity groups.

Table 3.1: Characteristics of adult Mexican smokers from ITC-Mexico waves III-V survey

Covariates of Interest	Non-daily ($n_{smokers}$=669 n_{obs} = 1,320)	Daily Light ($n_{smokers}$=643 n_{obs} = 1,285)	Daily Light ($n_{smokers}$=761 n_{obs} = 1,518)	
	32%	31%	37%	p-value
Socio-demographics				
Age				**<0.0001**
18 - 24	20%	19%	13%	
25 - 39	42%	36%	31%	
40 - 54	26%	26%	34%	
>54	13%	20%	22%	
Gender				**<0.0001**
Female	40%	41%	33%	
Marital Status				**<0.0001**
Married	69%	65%	67%	
Single	24%	22%	20%	
Other	7%	13%	14%	
Education				**<0.0001**
Primary Education or less	28%	30%	38%	
Middle School	33%	32%	29%	
Vocational school / HS / Incomplete University	29%	27%	24%	
University & Postgraduate	10%	10%	9%	
Income				**0.007**
0 - 3,000	27%	25%	25%	
3,001 - 5,000	30%	28%	29%	
5,001 - 8,000	21%	21%	20%	
> 8,000	16%	16%	18%	
Missing	6%	10%	8%	
Quit Behavior				
Intentions to quit in next six months				**<0.0001**
Yes	22%	16%	14%	
Attempted to quit in previous year				**<0.0001**
Yes	42%	33%	26%	

Covariates of Interest	Non-daily ($n_{smokers}$=669 n_{obs} = 1,320)	Daily Light ($n_{smokers}$=643 n_{obs} = 1,285)	Daily Light ($n_{smokers}$=761 n_{obs} = 1,518)	
	32%	31%	37%	p-value
Measures of Addiction				
Age at first cigarette				**<0.0001**
<= 16 years	50%	53%	61%	
Perceived addiction				**<0.0001**
Not at all	42%	21%	6%	
Little	48%	51%	32%	
Very much	10%	28%	62%	
Social Norms				
Descriptive Norms				
Partner / spouse smoking status				**0.025**
Yes	25%	26%	23%	
No	41%	35%	40%	
No Partner	34%	39%	37%	
# of smokers in five closest friends				0.074
None	10%	10%	11%	
1 to 3	48%	46%	42%	
4 or 5	43%	44%	47%	
Subjective Norms				
Perception of what important people think about their smoking				0.275
Agree / Strongly agree	78%	79%	76%	
*Anti-smoking societal norms^*				0.8519
	3.35 (0.87)	3.3 (0.86)	3.34 (0.88)	
Wave of participation				0.309
3	30%	29%	29%	
4	37%	35%	39%	
5	33%	36%	33%	
Time in sample				0.569
1	52%	51%	51%	
2	33%	32%	34%	
3	16%	17%	15%	

^ mean(std)

Table 3.2: Factors associated with smoking transition at follow-up among 916 non-daily smokers constituting 1,311 observations

	Bivariate Association		**Model-II**		**Full Model**	
	Quitter vs Stable OR (95% CI)	**Increase vs Stable OR (95% CI)**	**Quitter vs Stable OR (95% CI)**	**Increase vs Stable OR (95% CI)**	**Quitter vs Stable OR (95% CI)**	**Increase vs Stable OR (95% CI)**
Block-I: Measures of Addiction						
Age at first cigarette						
> 16 years	REF	REF	REF	REF	REF	REF
<= 16 years	1.01	0.83	0.97	0.79	1	0.78
	[0.686 - 1.490]	[0.604 - 1.144]	[0.661 - 1.437]	[0.583 - 1.084]	[0.675 - 1.490]	[0.566 - 1.081]
Perceived addiction						
Not at all	REF	REF	REF	REF	REF	REF
Little	**0.61***	1.48	**0.63***	**1.54***	**0.60***	**1.64***
	[0.404 - 0.919]	[0.996 - 2.196]	**[0.424 - 0.949]**	**[1.050 - 2.249]**	**[0.398 - 0.914]**	**[1.109 - 2.420]**
Very much	**0.39***	**2.08***	**0.35***	**1.86***	**0.34***	**1.94***
	[0.170 - 0.898]	**[1.086 - 3.986]**	**[0.149 - 0.829]**	**[1.039 - 3.321]**	**[0.142 - 0.830]**	**[1.056 - 3.554]**

	Bivariate Association		Model-II		Full Model	
	Quitter vs Stable OR (95% CI)	**Increase vs Stable OR (95% CI)**	**Quitter vs Stable OR (95% CI)**	**Increase vs Stable OR (95% CI)**	**Quitter vs Stable OR (95% CI)**	**Increase vs Stable OR (95% CI)**
Block II: Measures of Social norms						
Descriptive norms						
Partner / spouse smoking status						
Yes	REF	REF	REF	REF	REF	REF
No	**1.70***	0.99	1.59	0.91	**1.63***	0.95
	[1.068 - 2.691]	[0.670 - 1.471]	[0.992 - 2.537]	[0.585 - 1.416]	**[1.014 - 2.610]**	[0.611 - 1.492]
No Partner	**2.25****	1.41	**1.99****	1.15	**2.03****	1.18
	[1.336 - 3.781]	[0.914 - 2.178]	**[1.212 - 3.261]**	[0.741 - 1.781]	**[1.249 - 3.297]**	[0.765 - 1.825]
# of smokers in five closest friends						
None	REF	REF	REF	REF	REF	REF
1 to 3	0.91	1.22	1	1.37	0.99	1.4
	[0.567 - 1.457]	[0.640 - 2.314]	[0.612 - 1.627]	[0.722 - 2.586]	[0.607 - 1.614]	[0.713 - 2.741]
4 or 5	0.7	1.1	0.74	1.19	0.75	1.25
	[0.418 - 1.163]	[0.581 - 2.093]	[0.424 - 1.286]	[0.626 - 2.260]	[0.425 - 1.315]	[0.641 - 2.454]

	Bivariate Association		Model-II		Full Model	
	Quitter vs Stable OR (95% CI)	**Increase vs Stable OR (95% CI)**	**Quitter vs Stable OR (95% CI)**	**Increase vs Stable OR (95% CI)**	**Quitter vs Stable OR (95% CI)**	**Increase vs Stable OR (95% CI)**
Subjective norms						
Perception of what important people think about their smoking						
Not agree	REF	REF	REF	REF	REF	REF
Agree / Strongly agree	0.65	**0.66***	0.67	0.68	0.74	**0.63***
	[0.409 - 1.037]	**[0.446 - 0.990]**	[0.445 - 1.018]	[0.462 - 1.001]	[0.449 - 1.210]	**[0.419 - 0.948]**
Anti-smoking societal Norms						
	0.89	0.92	0.93	0.92	0.95	0.96
	[0.732 - 1.078]	[0.746 - 1.121]	[0.756 - 1.152]	[0.754 - 1.132]	[0.752 - 1.186]	[0.782 - 1.168]
Block III: Quit Behavior						
Attempted to quit in the previous year						
No	REF	REF	REF	REF	REF	REF
Yes	**1.46***	0.87	**1.61***	0.93	**1.53***	1
	[1.007 - 2.116]	[0.619 - 1.223]	**[1.101 - 2.361]**	[0.654 - 1.309]	**[1.025 - 2.273]**	[0.696 - 1.437]

	Bivariate Association		Model-II		Full Model	
	Quitter vs Stable OR (95% CI)	**Increase vs Stable OR (95% CI)**	**Quitter vs Stable OR (95% CI)**	**Increase vs Stable OR (95% CI)**	**Quitter vs Stable OR (95% CI)**	**Increase vs Stable OR (95% CI)**
Intending to quit in next six-months						
No	REF	REF	REF	REF	REF	REF
Yes	1.4	**0.65***	1.43	**0.65***	1.28	0.65
	[0.968 - 2.023]	**[0.436 - 0.954]**	[0.962 - 2.134]	**[0.438 - 0.975]**	[0.846 - 1.929]	[0.425 - 1.004]

*** p<0.001, ** p<0.01, * p<0.05

Model II: Model with each of the measure adjusted for socio-demographics (Age, gender, education, Income, survey wave & time in sample)

Full Model: Measures from each block adjusted for socio-demographics (Age, gender, education & Income)

Table 3.3: Factors associated with smoking transition at the follow-up among 937 daily-light smokers constituting 1,281 observations

	Bivariate Association		**Model-II**		**Full Model**	
	Quit/reduce vs Stable	**Increase vs Stable**	**Quit/reduce vs Stable**	**Increase vs Stable**	**Quit/reduce vs Stable**	**Increase vs Stable**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Block-I: Measures of Addiction						
Age at first cigarette						
> 16 years	REF	REF	REF	REF	REF	REF
<= 16 years	0.88	1.43	0.92	1.43	1.02	1.38
	[0.663 - 1.157]	[0.975 - 2.111]	[0.692 - 1.231]	[0.958 - 2.120]	[0.766 - 1.365]	[0.929 - 2.051]
Perceived addiction						
Not at all	REF	REF	REF	REF	REF	REF
Little	**0.53*** **	1.02	**0.56** **	1.05	**0.60** **	1.1
	[0.368 - 0.765]	[0.605 - 1.703]	**[0.387 - 0.805]**	[0.635 - 1.748]	**[0.411 - 0.868]**	[0.662 - 1.826]
Very much	**0.38*** **	**1.96***	**0.39*** **	**2.07** **	**0.39*** **	**2.02***
	[0.242 - 0.581]	**[1.141 - 3.355]**	**[0.247 - 0.602]**	**[1.220 - 3.498]**	**[0.251 - 0.619]**	**[1.170 - 3.480]**

	Bivariate Association		Model-II		Full Model	
	Quit/reduce vs Stable	**Increase vs Stable**	**Quit/reduce vs Stable**	**Increase vs Stable**	**Quit/reduce vs Stable**	**Increase vs Stable**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Block II: Measures of Social norms						
Descriptive norms						
Partner / spouse smoking status						
Yes	REF	REF	REF	REF	REF	REF
No	1.4	1.44	1.26	1.21	1.02	1.06
	[0.932 - 2.091]	[0.889 - 2.318]	[0.789 - 2.010]	[0.746 - 1.969]	[0.675 - 1.538]	[0.654 - 1.717]
No Partner	1.18	1.47	1.03	1.35	0.87	2.2
	[0.795 - 1.760]	[0.897 - 2.399]	[0.685 - 1.551]	[0.804 - 2.270]	[0.398 - 1.921]	[0.788 - 6.130]
# of smokers in five closest friends						
None	REF	REF	REF	REF	REF	REF
1 to 3	1.24	1	1.2	0.97	1.17	1.03
	[0.711 - 2.155]	[0.554 - 1.821]	[0.662 - 2.192]	[0.541 - 1.727]	[0.635 - 2.140]	[0.556 - 1.920]
4 or 5	1.14	1.19	1.07	1.05	1.06	1.16
	[0.663 - 1.945]	[0.642 - 2.211]	[0.597 - 1.930]	[0.553 - 1.994]	[0.592 - 1.911]	[0.591 - 2.264]

	Bivariate Association		Model-II		Full Model	
	Quit/reduce vs Stable	**Increase vs Stable**	**Quit/reduce vs Stable**	**Increase vs Stable**	**Quit/reduce vs Stable**	**Increase vs Stable**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Subjective norms Perception of what important people think about their smoking						
Not strongly agree	REF	REF	REF	REF	REF	REF
Strongly agree	0.84	0.96	0.88	1.04	0.9	1.15
	[0.548 - 1.279]	[0.551 - 1.656]	[0.567 - 1.364]	[0.616 - 1.743]	[0.574 - 1.409]	[0.655 - 2.004]
Anti-smoking societal Norms	**0.82***	**0.7****	0.86	**0.74****	0.87	**0.73****
	[0.672–0.987]	**[0.571 – 0.875]**	[0.702 - 1.046]	**[0.61 – 0.923]**	[0.712 - 1.057]	**[0.576 – 0.913]**
Block III: Quit Behavior						
Attempted to quit in the previous year						
No	REF	REF	REF	REF	REF	REF
Yes	1.41	**0.60***	**1.41***	**0.63***	1.31	**0.62***
	[0.989 - 2.015]	**[0.388 - 0.919]**	**[1.012 - 1.972]**	**[0.418 - 0.944]**	[0.942 - 1.816]	**[0.413 - 0.940]**

	Bivariate Association		Model-II		Full Model	
	Quit/reduce vs Stable	**Increase vs Stable**	**Quit/reduce vs Stable**	**Increase vs Stable**	**Quit/reduce vs Stable**	**Increase vs Stable**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Intending to quit in next six-months						
No	REF	REF	REF	REF	REF	REF
Yes	**1.83****	0.96	**1.90****	0.98	**1.80****	1.07
	[1.213 - 2.773]	[0.533 - 1.735]	**[1.239 - 2.907]**	[0.549 - 1.759]	**[1.179 - 2.735]**	[0.592 - 1.948]

*** p<0.001, ** p<0.01, * p<0.05

Model II: Model with each of the measure adjusted for socio-demographics (Age, gender, education, Income, survey wave & time in sample)

Full Model: Measures from each block adjusted for socio-demographics (Age, gender, education & Income)

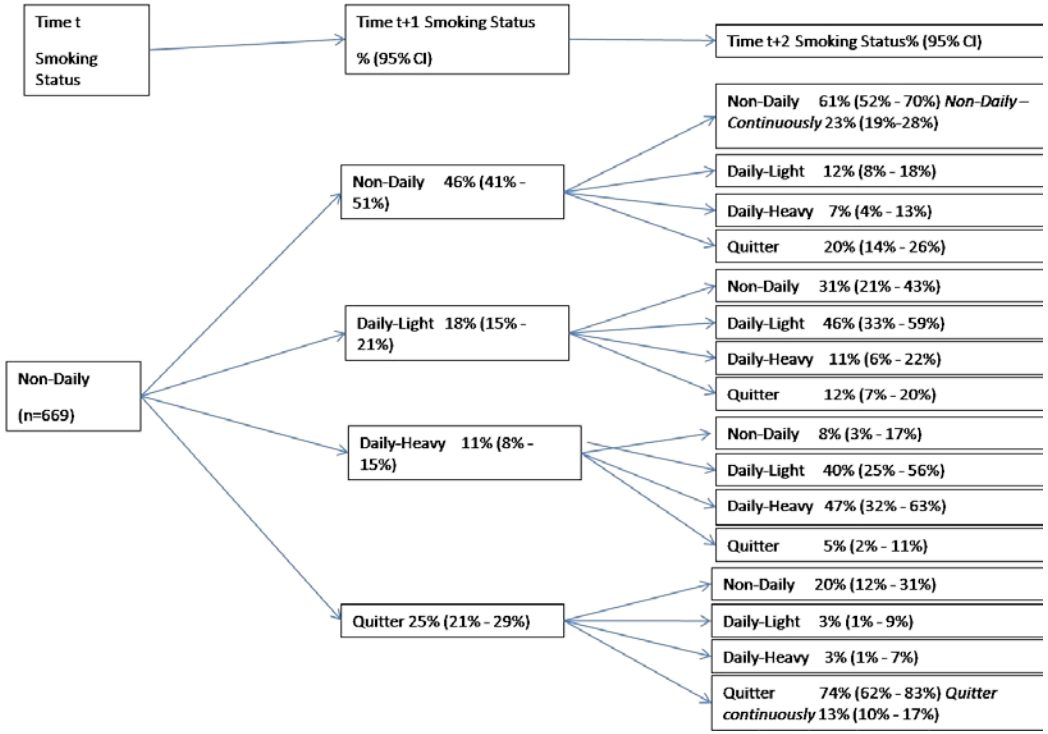
Table 3.4: Factors associated with smoking transition at the follow-up among 956 daily-heavy smokers constituting 1,514 observations

	Bivariate Association	**Model-II**	**Full Model**
	Quit or reduce vs Stable	**Quit or reduce vs Stable**	**Quit or reduce vs Stable**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Block I: Measures of Addiction			
Age at first cigarette			
> 16 years	REF	REF	REF
<= 16 years	0.77	0.76	0.84
	[0.591 - 1.006]	[0.577 - 1.012]	[0.628 - 1.127]
Perceived addiction			
Not at all	REF	REF	REF
Little	0.9	0.87	0.87
	[0.498 - 1.631]	[0.464 - 1.625]	[0.462 - 1.653]
Very much	**0.48***	**0.46****	**0.47***
	[0.278 - 0.843]	**[0.259 - 0.823]**	**[0.262 - 0.849]**
Block II: Measures of Social norms			
Descriptive norms			
Partner / spouse smoking status			
Yes	REF	REF	REF
No	0.97	1	0.99
	[0.661 - 1.434]	[0.682 - 1.453]	[0.666 - 1.470]
No Partner	**1.55***	1.82	1.85
	[1.078 - 2.238]	[0.978 - 3.386]	[0.993 - 3.464]

	Bivariate Association Quit or reduce vs Stable OR (95% CI)	Model-II Quit or reduce vs Stable OR (95% CI)	Full Model Quit or reduce vs Stable OR (95% CI)
# of smokers in five closest friends			
None	REF	REF	REF
1 to 3	0.96	0.81	0.78
	[0.636 - 1.449]	[0.518 - 1.269]	[0.489 - 1.230]
4 or 5	1.27	0.97	0.99
	[0.839 - 1.910]	[0.618 - 1.512]	[0.622 - 1.581]
Subjective norms			
Perception of what important people think about their smoking			
Not strongly agree	REF	REF	REF
Strongly agree	1.03	1.14	1.1
	[0.733 - 1.449]	[0.786 - 1.658]	[0.744 - 1.612]
Anti-smoking societal Norms			
	1.03	1.07	1.1
	[0.867 - 1.221]	[0.912 - 1.267]	[0.921 - 1.321]
Block III: Quit Behavior			
Attempted to quit in the previous year			
No	REF	REF	REF
Yes	1.05	1	0.91
	[0.777 - 1.418]	[0.735 - 1.367]	[0.654 - 1.272]
Intending to quit in next six-months			
No	REF	REF	REF
Yes	**1.55***	**1.54***	**1.59***
	[1.049 - 2.293]	**[1.044 - 2.284]**	**[1.044 - 2.410]**

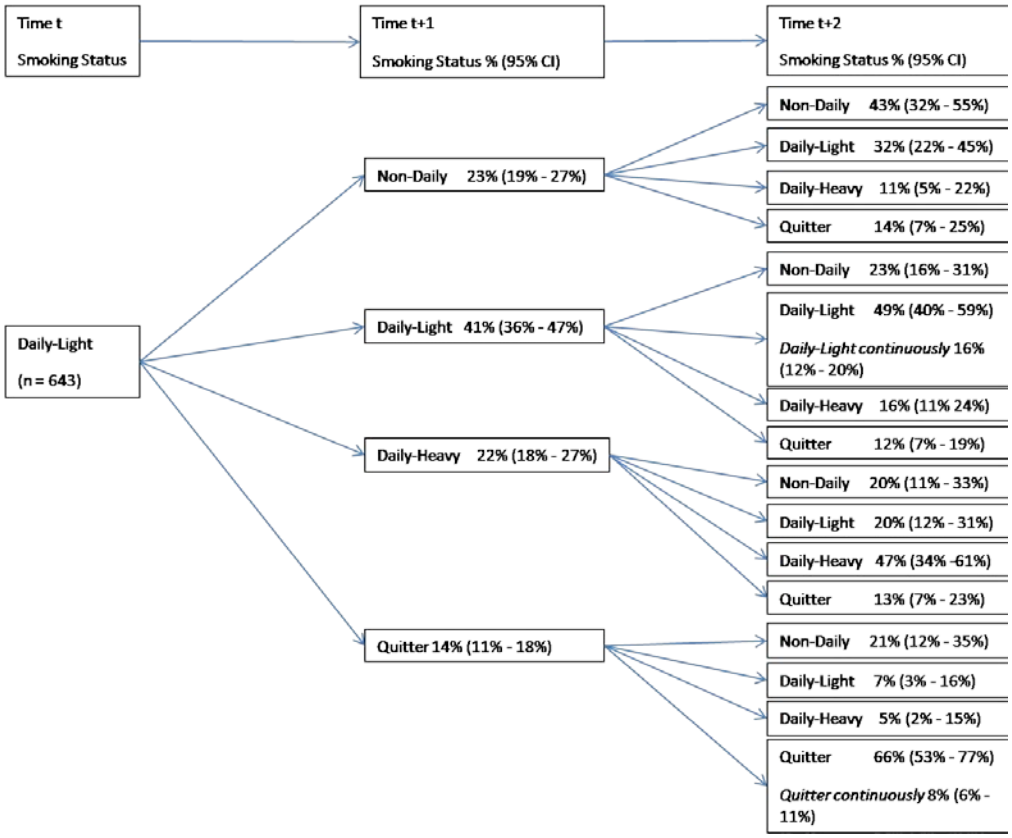
	Bivariate Association	Model-II	Full Model
	Quit or reduce vs Stable	Quit or reduce vs Stable	Quit or reduce vs Stable
	OR (95% CI)	OR (95% CI)	OR (95% CI)

*** p<0.001, ** p<0.01, * p<0.05; Model II: Model with each of the measure adjusted for socio-demographics (Age, gender, education, Income, survey wave & time in sample); Full Model: Measures from each block adjusted for socio-demographics (Age, gender, education, Income, survey wave & time in sample)



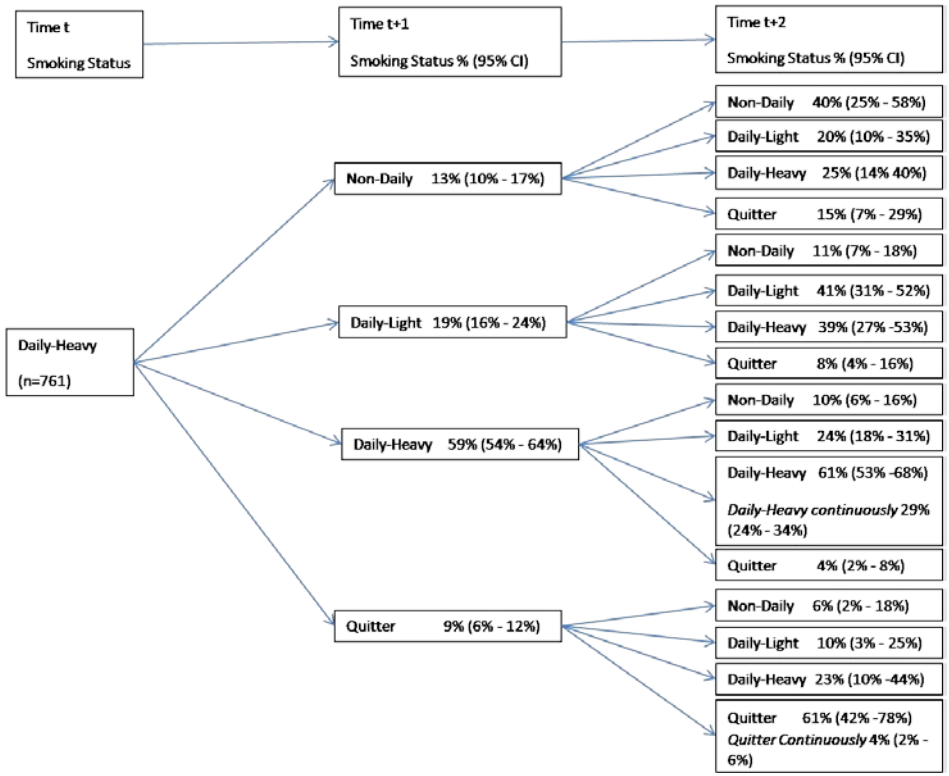
For smokers who remained in the same smoking category for t+1 and t+2, a second proportion (with phrase "continuously") reflects respondents who stayed in the same category and reported no increased or decreased consumption over the period of three interviews. The probability of being in a specific smoking status at t+1 is conditional on smoking status at t. Probabilities are expressed as percentages and probabilities of transition from t to t+1 sum to 100% within categories of smoking status at t. Estimated probabilities from t+1 to t+2 are conditional on prior status and sum to 100% within each unique combination of t and t+1 smoking status.

Figure 3.1: Smoking transitions from time t to t+1 and t+2 among smokers who were non-daily smokers at time t



For smokers who remained in the same smoking category for t+1 and t+2, a second proportion (with phrase "continuously") reflects respondents who stayed in the same category and reported no increased or decreased consumption over the period of three interviews. The probability of being in a specific smoking status at t+1 is conditional on smoking status at t. Probabilities are expressed as percentages and probabilities of transition from t to t+1 sum to 100% within categories of smoking status at t. Estimated probabilities from t+1 to t+2 are conditional on prior status and sum to 100% within each unique combination of t and t+1 smoking status.

Figure 3.2: Smoking transitions from Time t to t+1 and t+2 among smokers who were daily-light smokers at time t



For smokers who remained in the same smoking category for t+1 and t+2, a second proportion (with phrase "continuously") reflects respondents who stayed in the same category and reported no increased or decreased consumption over the period of three interviews. The probability of being in a specific smoking status at t+1 is conditional on smoking status at t. Probabilities are expressed as percentages and probabilities of transition from t to t+1 sum to 100% within categories of smoking status at t. Estimated probabilities from t+1 to t+2 are conditional on prior status and sum to 100% within each unique combination of t and t+1 smoking status.

Figure 3.3: Smoking transitions from time t to t+1 and t+2 among smokers who were daily-heavy smokers at baseline

CHAPTER 4

Impact of smoke-free policies on smoking behaviors in a population of low-intensity smokers: Findings from the ITC-Mexico surveys

4.1: INTRODUCTION

The WHO Framework Convention on Tobacco Control (FCTC), the first ever global public health treaty, mandates ratifying countries to adopt comprehensive smoke-free laws to protect citizens from exposure to secondhand smoke (SHS) smoke in workplaces, public transport and other indoor public places (68). In 2004, Mexico became the first country in the Americas to ratify the WHO FCTC. In 2008, Mexico City adopted the Smoke-Free Workplace Act that prohibited smoking in enclosed public places (i.e., bars, restaurants), workplaces, and in public transportation, making Mexico City the first 100% smoke-free city in Mexico (135, 136). In the same year, the Mexican President signed the General Tobacco Control Law (GLTC), (137) which prohibited most types of tobacco product advertising, stipulated pictorial health warning labels on cigarette packages, and established smoke-free areas within public places and workplaces. According to GLTC, smoking is prohibited in most indoor public places and workplaces, as well as in primary schools, secondary and high schools. However, this was a partial smoke-free law as it allowed designated smoking areas (smoking only areas) as long as these areas had a separate ventilating system and were physically

separated by walls from the rest of the venue. Until these policies were implemented, smoke-free policies in Mexico were limited to government buildings and hospitals (133), and compliance was generally very low (134).

Though the primary goal of smoke-free policies is to eliminate involuntary exposure to SHS and, thereby, improve public health, smoke-free policies can also promote smoking cessation by increasing the awareness of smoking harms (208), limiting smoker's opportunities to smoke (105, 106), increasing the social stigma attached to smoking (112, 120), and reducing socially cued smoking (107, 209). A recent study showed that smoke-free policies can serve as a self-control device for smokers who are trying to quit (210). This study showed that smokers who support smoke-free policies are more likely to quit following the implementation of smoke-free policy. Early studies that evaluated the effectiveness of workplace smoke-free policies on smoking behavior in high-income countries (HICs) have consistently shown that smoke-free workplaces reduce the amount of cigarettes consumed, increase the number of quit attempts and increase cessation rates (85, 112-117). However, more recent studies of national-level comprehensive smoke-free policies have been inconclusive. Studies that collected data at shorter intervals before and after implementation of the policy captured some favorable changes in smoking behaviors (88, 122, 126-129). In England, for example, a comprehensive smoke-free policy was introduced on July 1, 2007. A study that looked at smoking behavior information collected by month found that attempts to quit smoking were greater during the two months following the implementation of the smoke-free policy in comparison to an analogous 2-month period

the previous year (127). The studies that show an immediate temporary increase in quit attempts, reduction in amount smoked, usage of cessation services and increased smoking quit ratios suggests that smoke-free policies are effective in bringing some changes in smoking behaviors. However, studies in HICs that looked at changes in national smoking trends as a result of national comprehensive smoke-free policies (88, 119) and studies that used longer duration of follow-up data (71, 119-125) did not find a relationship between smoke-free policies and reduction in smoking prevalence. Several factors could have influenced the lack of association between comprehensive smoke-free policies and reduction in smoking prevalence. Several local and state-level jurisdictions in HICs implemented comprehensive smoke-free policies before a nation-wide policy went into effect. Hence, the incremental effect of national smoke-free policies on reduction in smoking might be minimal. Also, in the studies that found an association between smoke-free policies and cessation behaviors, the effect sizes were small (88, 122, 126-129). So the small increases in smoking cessation might not be reflected in national smoking trends. To our knowledge, there have been no studies that have evaluated the effectiveness of smoke-free policies in modifying smoking behaviors in low- and middle-income countries (LMICs), where the history and strength of tobacco control environments may not be comparable to that of HICs.

Mexico, a middle-income country, has a cultural context and population profile of smoking intensity that are quite different from HICs. Mexican smokers are more likely to be non-daily smokers and to consume a lower number of cigarettes per day (CPD) compared to smokers from majority ethnic groups in western countries (1, 5).

Smokers with lower levels of consumption reported less tobacco dependence (18) and experienced fewer cravings during a quit attempt compared to heavier smokers (37), suggesting that quitting may be easier for smokers with lower levels of consumption. A study conducted in the US showed that environmental restrictions, such as smoke-free policies, are more effective in promoting cessation behavior among non-daily smokers in comparison to daily smokers (138). Latinos in the US were more likely to view their smoking as a result of social and environmental cues and less of physical dependence (32, 33). Additionally, they cited concerns about family and interpersonal relations as important reasons to quit. Given this cultural context, along with the predominance of low levels of cigarette consumption, smoke-free policies might have a greater impact on promoting smoking cessation among Mexicans. So far the impact of smoke-free policies on smoking behaviors has been studied in populations that smoke at higher average levels than countries such as Mexico. To my knowledge there have been no studies to date that looked at the effects of smoke-free policy on smoking behaviors in a population of light smokers.

Using the Mexico administration of the International Tobacco Control Policy Evaluation Project (ITC) data, the present study aims to: 1) evaluate the association between Mexico City's comprehensive smoke-free policy and the federal partial smoke-free policy on cessation behaviors; 2) examine if Mexico City's comprehensive smoke-free policy was more effective in promoting cessation behaviors than the federal partial smoke-free policy; and 3) examine if there was a differential impact of smoke-free policies on quit behaviors across different smoking intensity groups. We hypothesize

three relationships to emerge. First, (a) compared to smokers who are not exposed to SHS at workplaces, smokers who are exposed to SHS at workplaces are less likely to attempt to quit and quit successfully by the follow-up periods and (b) compared to smokers who are not exposed to SHS at hospitality industry venues, smokers who are exposed to SHS at hospitality industry venues are less likely to attempt to quit and quit successfully by the follow-up. Second, we hypothesize that, compared to smokers who are not exposed to SHS at workplaces and hospitality industry venues in Mexico City, which has comprehensive smoke-free policy, smokers who are not exposed to SHS at workplaces and hospitality industry venues in places that implement the federal partial smoke-free policy are less likely to attempt to quit and quit successfully. Finally, we hypothesize that, compared to daily-heavy smokers, non-daily and daily-light smokers who are not exposed to SHS at workplaces and hospitality industry venues are more likely to attempt to quit and quit successfully by the follow-up period than those who are exposed to SHS at workplaces and hospitality industry venues.

4.2: METHODS:

Study Setting and Population:

The Mexican administration of the ITC project started in 2006, and six waves of data were collected up through 2012. In the first wave of data collection, four major cities were sampled. In wave III, three other cities were included, and starting wave IV, one of the original four cities was replaced by a different city because of difficulties with data collection (i.e., concerns for interviewer safety).

Within the selected cities, stratified, multi-stage sampling was used. Census tracts and then block groups were selected with probability proportional to the number of households according to the 2000 or 2005 census (used for the first four cities and the more recently introduced cities, respectively). Within blocks, a random sample of smokers was selected, and face-to-face interviews were conducted. To maintain the sample sizes across waves, samples were replenished with adult smokers from already selected census tracts or randomly selected census tracts that were adjacent to the originally selected tracts.

In this study, data collected from the seven cities that participated in waves III, IV, V and VI were analyzed (Guadalajara, Léon, Mérida, Mexico City, Monterey, Puebla and Tijuana). Wave III was administered in November–December of 2008, wave IV in January–February of 2010, wave V in April–May 2011, and wave VI in October–December 2012. Participants with at least one consecutive wave of follow-up were included in the analysis.

Measures

Exposure to SHS:

Not all individuals were exposed to smoke-free policies, as smoke-free legislation differed across cities and within cities over time, and also not all workplaces and hospitality industry venues complied with smoke-free policies. In order to account for variation in exposure to policy, individual-level self-reported exposure to SHS at workplaces and hospitality industry were used as proxy measures of compliance with the smoke-free policy.

To assess exposure to SHS at workplaces, participants at each wave who were in paid work and worked indoors were asked “In the last month, have people smoked in indoor areas where you work?” Participants who were not employed in paid indoor work were considered as not being exposed to the smoke-free workplace policy. The responses were coded as “not exposed to the smoke-free workplace policy,” “not exposed to SHS at workplaces,” or “exposed to SHS at workplaces”.

To assess exposure to SHS at hospitality venues, i.e., restaurants or cafés and bars or discos, participants at each wave were asked if they had been to these public venues in the past 6 months. Smokers who had been to the venue at least once in the past 6 months were asked if, during their most recent visit, anyone smoked inside these places. For the main analysis, we considered participants who had not visited the venues in the past month as being not exposed to the hospitality industry smoke-free policy. Responses were categorized as “not exposed to the smoke-free policy at hospitality industry venues in the past month.”, “not exposed to SHS at hospitality industry venues”, or “exposed to SHS at hospitality industry venues”. To increase the sample size of participants who are exposed to the hospitality industry smoke-free policy in sensitivity analyses, we considered participants who had not visited the venues in the six-months as being not exposed to the hospitality industry smoke-free policy and the responses options were categorized as “not exposed to the smoke-free policy at hospitality industry venues in the six-months”, “not exposed to SHS at hospitality industry venues”, or “exposed to SHS at hospitality industry venues”.

Type of smoke-free policy:

The city where a participant lived was used to code the type of smoke-free policy. Mexico City participants were coded as being exposed to a comprehensive policy, while participants from the other five cities were coded as being exposed to the federal partial smoke-free policy.

Smoking Intensity:

Smoking intensity was determined by asking participants at each wave to report daily or non-daily smoking, as well as the average number of cigarettes they smoked on the days that they smoked (CPD). Based on the response to these questions, smoking intensity was classified as: non-daily, daily-light (daily smoking <= 5 CPD), and daily-heavy (daily smoking > 5 CPD) smokers. These categories generally reflect tertiles of consumption intensity in Mexico, and are also informed by previous research that has considered the low-level of smoking among Latinos (29).

Quit behavior:

At the follow-up, people who indicated that they had quit were asked how long ago they had quit. Participants who had quit for more than 30 days were coded as quitters, as suggested by previous research (19). People who continued to smoke at the follow-up were asked if they had attempted to quit in between the waves. Participants who responded affirmatively and participants who successfully quit by the follow-up period were coded as having made an attempt to quit in between waves. Quit intentions were assessed by asking whether participants planned to quit in the next month, in the next

six months, sometime beyond six months, or not at all, with responses dichotomized to indicate intention to quit within the next six months versus not.

Socio-demographic variables:

Socio-demographic variables included self-reported age (18 – 24 years, 25 – 39 years, 40 – 54 years, 55 years and older); gender (male and female); marital status (married or in a partnership, single and other); educational attainment (less than middle school, middle school, technical/vocational course, high school, University graduate); and household income (0 – 3000, 3001 – 5000, 5001 – 8000, more than 8001 pesos per month).

Statistical Analysis:

All analyses were performed in SAS 9.3. The complex survey design, weighting and the repeated nature of the observations were appropriately adjusted for in conducting the analyses. Smokers with at least one wave of follow-up data were included in the analyses. Chi-square tests were conducted to compare the analytic sample to the attrition sample.

Generalized Estimating Equations (GEE) with log-binomial models were run to examine the association between self-reported compliance exposure to SHS at workplaces and hospitality venues at time 't' and quit behaviors (i.e., attempting to quit and successful quitting) at the follow-up period (i.e., time 't+1'). Given that the prevalence of outcomes was higher than 10%, risk ratios (RRs) using log-binomial models were calculated rather than odds ratios (ORs) using logit models. Three sets of models were run for each of the two quit behavior outcomes. One bivariate model and

two separate adjusted models for each of the exposure to SHS measures, i.e., separate models to examine the association between exposure to SHS at workplace and hospitality industry venues with quit behaviors. The models additionally adjusted for age, gender, marital status, education, income, smoking intensity, intention to quit in the next 6 months, wave of data collection, and number of times participated in the survey during the study period. The non-independence of repeated observations was adjusted through estimation with the working correlation structure, assuming an unstructured correlation for repeated observations within subjects. In order to examine if there was any differential association between exposure to SHS on quit behavior by the type of ban (comprehensive versus partial) and by smoking intensity we included four interaction terms, testing for the significance of one interaction term at a time in a fully adjusted model. These interactions terms were exposure to SHS at workplaces * type of ban, exposure to SHS at workplaces * smoking intensity, exposure to SHS at hospitality industry venues * type of ban, and exposure to SHS at hospitality industry venues *smoking intensity. We also ran sensitivity analysis by expanding the exposure to SHS at hospitality venues from the previous month to exposure to SHS during the last visit in the past 6 months (Results not shown in tables).

4.3: RESULTS:

Sample Characteristics

The analytic sample was compared to the attrition sample that participated in only one wave of the survey (table 1). Compared to the attrition sample, smokers from the analytic sample were more likely to be older in age, female and less educated. There

were no statistically significant differences in smoking-related variables among the analytic and attrition samples. Compared to the attrition sample, smokers from the analytic sample were less likely to have paid work indoors, but more likely to have visited a hospitality venue in the past month and to have been exposed to SHS at hospitality industry venues.

Exposure to SHS and quit attempts

Neither exposure to SHS at workplaces nor exposure to SHS at hospitality industry venues was associated with attempting to quit, either in bivariate or adjusted models (table 2). In bivariate models, compared to daily-heavy smokers, non-daily and daily-light smokers were more likely to have attempted to quit by the follow-up period ($RR_{\text{Non-daily vs daily-heavy}} = 1.68$, 95% CI 1.5 – 1.89 & $RR_{\text{Daily-light vs daily-heavy}} = 1.25$, 95% CI 1.1 – 1.4). Compared to smokers who did not attempt to quit in the previous year as measured at the beginning of the study, smokers who attempted to quit in the previous year were more likely to have made another quit attempt during the follow-up period (RR= 1.3, 95% CI 1.19 – 1.44). Also, compared to smokers with no intention to quit in the next 6 months, smokers who intended to quit in next 6 months were more likely to have attempted to quit by the follow-up period (RR= 1.75, 95% CI 1.42 – 2.15). These results were slightly attenuated in adjusted models, but remained the same in direction and statistical significance. The interactions between exposure to SHS at workplaces with the full versus partial smoke-free policy (p = 0.966), exposure to SHS at hospitality industry venue with full versus partial smoke-free policy (p = 0.0812), exposure to SHS at workplaces with smoking intensity (daily heavy, daily light, non-daily) (p = 0.5454) and

exposure to SHS at hospitality industry venues with smoking intensity (p = 0.62) were not statistically significant.

Sensitivity analyses results assessing the exposure to SHS during the last visit to hospitality industry venues in the previous six-months showed a weak but statistically significant association between lack of SHS exposure at hospitality venues and attempting to quit by the follow-up period (Results not shown in tables). Compared to smokers who were not exposed to SHS at hospitality venues during their last visit in past six-months, smokers who did not visit hospitality venues in the past 6months and smokers who were exposed to SHS at hospitality venues were less likely to have attempted to quit ($RR_{\text{Not been the hospitality venue vs not exposed to SHS}}$ = 0.92, 95% CI 0.86 – 0.99 & $RR_{\text{exposed to SHS vs not exposed to SHS}}$ =0.91, 95% CI 0.84 – 0.99).

Exposure to SHS and quit success

Table 3 presents results for the association between exposure to SHS and quit success at the follow-up period (table 3). Compared to smokers who were not exposed to SHS at workplaces, smokers who were exposed to SHS at workplaces were more likely to be successful quitters by the follow-up period ($RR_{\text{Exposed to SHS vs not exposed to SHS}}$ = 1.37, 95% CI 1.06 – 1.77). There was no association between exposure to SHS at hospitality industry venues and quit success. In bivariate models, compared to daily-heavy smokers, non-daily and daily-light smokers were more likely to quit by the follow-up period ($RR_{\text{Non-daily vs daily-heavy}}$ = 2.76, 95% CI 2.14 – 3.57 & $RR_{\text{Daily-light vs daily-heavy}}$ = 1.62, 95% CI 1.23 – 2.13). Compared to smokers who did not attempt to quit in the previous year, smokers who attempted to quit were more likely to have quit by the follow-up period (RR= 1.54, 95%

CI 1.27 – 1.88). Also, compared to smokers who did not intend to quit in the next 6 months, smokers who intended to quit were more likely to have quit by the follow-up period (RR= 2.4, 95% CI 1.51 – 3.8). These results were slightly attenuated in adjusted models, but remained the same in direction and statistical significance. The interactions between exposure to SHS at workplaces with type of smoke-free policy (p = 0.514), exposure to SHS at hospitality venue with type of smoke-free policy (p = 0.3936), exposure to SHS at workplaces with smoking intensity (p = 0.6882) and exposure to SHS at hospitality industry venues with smoking intensity (p = 0.1468) were not statistically significant. Results from sensitivity analyses for the exposure to SHS at hospitality industry venues and quit success remained consistent in statistical significance to the results presented above ($RR_{\text{Not been the hospitality venue vs not exposed to SHS}}$ = 0.93, 95% CI 0.78 – 1.10& $RR_{\text{exposed to SHS vs not exposed to SHS}}$ =1.04, 95% CI 0.87 – 1.25).

4.4: DISCUSSION:

To our knowledge, this is first study to assess the impact of smoke-free policies on smoking behavior in LMICs. We found that lack of SHS exposure at workplaces was not associated with increased quit attempts and lack of SHS exposure at hospitality industry venues was also not associated with either increased quit attempts or quit success among a cohort of smokers in Mexico. Surprisingly, exposure to SHS at workplaces was associated with higher likelihood of quit success. The association between exposure to SHS at workplaces and hospitality venues and quit behaviors was not modified by the type of ban. Also, compared to daily-heavy smokers, smoke-free policies did not promote greater cessation among non-daily and daily-light smokers.

Contrary to most of the previous research in HICs that assessed impact of workplace smoke-free policies on smoking behavior (85, 112-117), our results suggest that smoke-free policies at workplaces was not associated with higher prevalence of quit attempts or quit success. In Mexico, smoke-free policies were limited to government buildings until the 2008 smoke-free policies were implemented. Given that this is the first time Mexico had strengthened the workplace smoking laws and people spend more time at worksites, and any restrictions at worksite are expected to influence behaviors more (211), we expected to see a greater impact of workplace smoke-free policies on smoking behavior. But in our results we did not find worksite restrictions resulting in greater cessation behaviors and instead found an increase in quit success among smokers who were exposed to SHS at workplaces. There were statistically significant differences in the socio-demographics and smoking-related characteristics between the participants who were exposed to SHS at workplaces in the past month and participants who were not exposed to SHS at workplaces in the past month. Apart from the differences in socio-demographics, participants who were exposed to SHS at workplaces in the past month were more likely to be daily-heavy smokers compared to the participants who were not exposed to SHS at workplaces (46% vs 32%, $p<0.0001$). The fact that the association between exposure to SHS at workplaces and quit success was statistically significant in adjusted models but not in bivariate association suggests that the differences in sample characteristics between the two groups might be accounting for this surprising finding. Also, our results indicate that lack of SHS exposure at hospitality industry venues was not associated with quit behaviors. This lack of impact

of smoke-free restrictions on cessation behavior could be because of the lag time between policy implementation and our study time period. Studies that collected data at shorter intervals during the policy implementation captured some changes in smoking behaviors (88, 122, 126-129). The data used in this study was post-policy data and from a few months after policy implementation to over three years after the policies were implemented. Smokers might be more likely to change their behavior right before the policy was implemented in anticipation of the policy or soon after the policy went into effect.

Our results also indicated that lack of SHS exposure in Mexico City, which has a comprehensive smoke-free policy, was no more likely to promote cessation behaviors than lack of SHS exposure in the rest of the cities that only have the partial federal policy. Previous research shows that the implementation of a comprehensive smoke-free policy in Mexico City resulted in significant declines in exposure to SHS at workplaces and hospitality industry venues within 8 months of policy implementation (96). This study also showed high levels non-compliance to smoke-free policies at workplaces post implementation of the comprehensive policy in Mexico City. The reduction in SHS exposure at hospitality industry venues but not workplaces was greater in Mexico City than in three other Mexican cities that implemented the federal smoke-free policies, suggesting that Mexico City's comprehensive smoke-free policies at hospitality industry venues are more effective in reducing the SHS exposure than the federal partial smoke-free policy (94). However, we did not find a greater impact of Mexico City's comprehensive policy in promoting cessation behaviors, unlike a study

from HICs that found comprehensive policies in Ireland and England promoting quit behaviors while the partial policy in Netherlands did not have any effect on cessation behaviors (131). This study, though, compared cessation behaviors from pre-law to a few months post-law and was able to capture the immediate increased cessation activity following the comprehensive smoke-free policies in Ireland and England. Even though compliance to Mexico City's comprehensive smoke-free policy is not comparable to that of HICs (88, 209), the comprehensive policy did bring significant reductions in exposure to SHS.

Only approximately 30% of our analytic sample attended hospitality industry venues in the past month. This limited scope of hospitality industry smoke-free policies might be a reason for not finding a relationship between hospitality industry smoke-free policy and cessation behaviors. Our sensitivity analyses increased the percentage of smokers who visited the hospitality industry venues from 37% to 56%. These results indicated a weak but statistically significant association between lack of SHS exposure at hospitality venues and attempting to quit by the follow-up period. Compared to smokers who were not exposed to SHS at hospitality venues, smokers who did not visit hospitality venues in the past 6months and smokers who were exposed to SHS at hospitality venues were less likely to have attempted to quit. However, this increase in quit attempts among smokers who were not exposed to SHS at hospitality industry venues did not translate to quit success. Research shows that the hospitality industry smoke-free policy might cause greater stigma regarding smoking and less social smoking cues (71). This might have promoted an increase in quit attempts among smokers as a

result of hospitality industry smoke-free policy. A study that examined the impact of smoke-free policies in local restaurants on anti-smoking attitudes and quitting behaviors among smokers from 351 Massachusetts towns found that smoke-free policies in restaurants reinforce anti-social smoking norms among smokers who already view smoking as socially unacceptable, and these policies encouraged smokers to make new quit attempts (71). Like in our sensitivity analysis, the increase in quit attempts as a result of visiting smoke-free compliant hospitality venues in this study did not translate to increased quit success. In order to increase quit success, countries implementing smoke-free policies should consider increasing the cessation resources around the time of smoke-free policy implementation.

We found that, compared to daily-heavy smokers, smoke-free policy did not promote greater cessation for non-daily and daily-light smokers. Previous research from the US has shown that smoke-free policies are more effective in promoting cessation among non-daily smokers in comparison to daily smokers (138). The lack of association in our study could partly be explained by the low cigarettes per day (CPD) among the daily-heavy smokers in our sample, which was substantially lower than is found for heavier daily smokers in the HICs (i.e., 12.7 CPD vs.18.9) (34, 212).

In our sample, only about a third of our smokers were exposed to the workplace and hospitality industry venues that are covered by the smoke-free policies. So it is important to expand the smoke-free policies to other places where Mexicans might be exposed to SHS smoke. Recent studies show that smoke-free policies that restrict smoking in multi-unit housings, public parks and privately owned vehicles while children

are present are supported by the public and are effective in reducing exposure to SHS (213-216). These policies could also strengthen the anti-smoking social norms and promote cessation behaviors.

This study has several limitations. The measurement of exposure to SHS at workplaces and hospitality industry venues was based on participant's exposure to SHS in the previous month. Hence, this measure may not capture the entire SHS exposure of the smoker at workplaces or hospitality industry venues. All the measures used in this study were self-reported and might potentially be prone to social desirability bias. Smokers may underreport their exposure to SHS if they do not feel comfortable reporting the violation. Even if there was an impact of smoke-free policy in promoting cessation behavior, the under-reporting of SHS exposure could lead to underestimation of the smoke-free policy impact. To address this issue, we used questions that ask smokers if 'anyone' has smoked not whether the participant has smoked. Also, given that the compliance to smoke-free policies in Mexico was low, we used self-reported exposure to SHS as a proxy measure of compliance to smoke-free policies. This allowed us to measure the association of the lack of SHS exposure on cessation behaviors. This social desirability bias might have also resulted in overestimation of quit behavior and underestimation of smoking intensity levels. We did not conduct biochemical verification of smoking abstinence. However, our results about the smoking intensity are in general consistent with those that have been found in other population-based surveys in Mexico (5, 187). Previous research involving an earlier survey administration in this study cohort also found reasonable correlation between self-reported

consumption level and saliva cotinine levels (205). This study suffered from loss to follow-up, with 73% follow-up from wave-III to IV, 83% follow-up from wave IV to V, and 79% follow-up from wave V to VI. This loss to follow-up may have introduced selection bias given that, compared to the attrition sample participants in the analytic sample were more likely to work indoors and less likely to go to hospitality venues in the past month. It is not clear whether this selection bias would lead to under- or over-estimation of study results. Lastly, the generalizability of these findings might also be limited by the fact that this study was conducted in seven of the major cities in Mexico and did not include rural areas. However, these seven cities include all major regions of the country, and about 78% of Mexicans live in urban areas (207).

Conclusions

This study found that lack of exposure to SHS at workplaces or hospitality industry venues was not associated with increased cessation activity among a cohort of Mexican smokers. The primary goal of smoke-free policies is to reduce the exposure to SHS; smoke-free policies in Mexico have been effective to an extent in reducing the SHS exposure and its health effects (94-96). However, compared to HICs, the compliance with smoke-free policies in Mexico has been low (88, 209) and the lack of comprehensive compliance may help explain our non-significant results. Government should take additional actions to adopt and improve compliance with comprehensive smoke-free policies. These actions could include, but are not limited to, more frequent inspections of the venues, higher fines for violations and conducting media campaigns

to raise awareness of the policies (68, 217, 218). Increased compliance as a result of these actions may also promote smoking cessation.

Table 4.1: Comparison between the analytic sample to attrition sample

Covariates of Interest	Analytic Sample (n_{obs}= 4,123 &$n_{smokers}$ = 2,100)	Attrition Sample ($n_{smokers}$ =771)	p-value
Socio-demographics			
Age			**0.0030**
18 - 24	17%	18%	
25 - 39	36%	39%	
40 - 54	29%	29%	
>54	18%	14%	
Gender			**0.0070**
Female	38%	34%	
Marital Status			0.6900
Married	67%	66%	
Single	22%	23%	
Other	12%	12%	
Education			**<0.0001**
Primary Education or less	32%	29%	
Middle School	31%	28%	
Vocational school / HS / Incomplete University	27%	32%	
University & Postgraduate	10%	12%	
Income			0.1150
0 - 3,000	26%	25%	
3,001 - 5,000	29%	31%	
5,001 - 8,000	21%	18%	
> 8,000	17%	17%	
Missing	8%	10%	
Smoking-related variables			
Smoking status			0.5280
Non-Daily	32%	33%	
Daily-Light	31%	30%	
Daily-Heavy	37%	38%	
Intentions to quit in next six months			0.7130
Yes	18%	17%	
Attempted to quit in previous year			0.3060
Yes	33%	32%	

Covariates of Interest	Analytic Sample (n_{obs}= 4,123 &$n_{smokers}$ = 2,100)	Attrition Sample ($n_{smokers}$ =771)	p-value
SHS Exposure Variables			
Exposure to SHS at workplaces			**0.005**
Not exposed to SHS	6%	8%	
Exposed to SHS	27%	30%	
Not exposed to the workplace smoke-free policy	67%	62%	
Exposure to SHS at hospitality industry venues			**<0.0001**
Not exposed to SHS	22%	14%	
Exposed to SHS	16%	16%	
Not exposed to the hospitality industry smoke-free policy	63%	70%	

Table 4.2: Association between self-reported exposure to SHS at workplaces and hospitality industry venues and attempting to quit by follow-up period

	Attempted to quit by follow-up period			
	Attempted to Quit n= 1,566 (38%)	**Bivariate Association RR (95% CI)**	**Adjusted Model-I RR (95% CI)**	**Adjusted Model-II RR (95% CI)**
Exposure to SHS at workplaces				
Not exposed to SHS	37%	REF	REF	
Not exposed to the workplace smoke-free policy	38%	1.01 (0.91 - 1.12)	1.04 (0.97 - 1.1)	**NA**
Exposed to SHS	39%	1.1 (0.9 - 1.36)	1.09 (0.97 - 1.23)	
Exposure to SHS at hospitality industry venues				
Not exposed to SHS	41%	REF		REF
Not exposed to the hospitality industry venue smoke-free policy	37%	0.93 (0.85 - 1.02)	**NA**	0.96 (0.88 - 1.05)
Exposed to SHS	39%	0.94 (0.83 - 1.06)		0.94 (0.84 - 1.05)
Type of Ban				
Partial	38%	REF	REF	REF
Comprehensive	37%	0.97 (0.84 - 1.1)	0.95 (0.88 - 1.02)	1.06 (0.98 - 1.15)
Smoking Intensity				
Non-daily	50%	**1.68*** (1.5 - 1.89)**	**1.5*** (1.39 - 1.61)**	**1.63*** (1.5 - 1.77)**
Daily-Light	38%	**1.25*** (1.1 - 1.4)**	**1.19*** (1.09 - 1.29)**	**1.24 *** (1.13 - 1.36)**
Daily-Heavy	28%	REF	REF	REF
Interactions				
Exposure to SHS at workplace * type of ban	**NA**	**NA**	0.9666	**NA**

	Attempted to quit by follow-up period			
	Attempted to Quit n= 1,566 (38%)	**Bivariate Association RR (95% CI)**	**Adjusted Model-I RR (95% CI)**	**Adjusted Model-II RR (95% CI)**
Exposure to SHS at workplace * smoking intensity			0.5454	
Exposure to SHS at hospitality industry venues * type of ban				0.0812
Exposure to SHS at hospitality industry venues * smoking intensity			**NA**	0.62
Socio-demographics				
Age				
18 - 24	40%	REF	REF	REF
25 - 39	40%	0.97 (0.83 - 1.14)	0.99 (0.91 - 1.08)	0.98 (0.9 - 1.07)
40 - 54	37%	0.98 (0.84 - 1.15)	1.06 (0.97 - 1.16)	1.08 (0.98 - 1.19)
>54	38%	1.03 (0.87 - 1.22)	**1.14* (1.01 - 1.27)**	**1.17* (1.04 - 1.3)**
Gender				
Male	37%	REF	REF	REF
Female	39%	1.06 (0.95 - 1.15)	1.01 (0.96 - 1.08)	1 (0.94 - 1.07)
Marital Status				
Married	38%	REF	REF	REF
Single	40%	1.01 (0.89 - 1.13)	1.02 (0.95 - 1.1)	1.03 (0.95 - 1.11)
Other	35%	0.93 (0.79 - 1.1)	0.97 (0.87 - 1.08)	0.98 (0.87 - 1.1)

	Attempted to quit by follow-up period			
	Attempted to Quit n= 1,566 (38%)	**Bivariate Association RR (95% CI)**	**Adjusted Model-I RR (95% CI)**	**Adjusted Model-II RR (95% CI)**
Education				
Primary Education or less	36%	REF	REF	REF
Middle School	39%	1.08 (0.95 - 1.22)	**1.1* (1.01 - 1.19)**	**1.13 ** (1.04 - 1.24)**
Vocational school / HS / Incomplete University	40%	1.08 (0.95 - 1.24)	**1.1* (1.02 - 1.21)**	**1.15 ** (1.04 - 1.26)**
University & Postgraduate	40%	1.11 (0.92 - 1.33)	**1.19** (1.06 - 1.34)**	**1.25 *** (1.1 - 1.42)**
Income				
0 - 3,000	41%	REF	REF	REF
3,001 - 5,000	38%	1.02 (0.9 - 1.15)	0.99 (0.92 - 1.07)	0.98 (0.91 - 1.06)
5,001 - 8,000	36%	0.9 (0.78 - 1.04)	**0.89* (0.81 - 0.98)**	**0.87 ** (0.78 - 0.96)**
> 8,000	36%	0.95 (0.81 - 1.1)	**0.89* (0.8 - 0.99)**	**0.86 * (0.77 - 0.97)**
Missing	39%	0.97 (0.81 - 1.16)	**0.89* (0.79 - 1)**	0.88 (0.77 - 1.00
Attempted to quit in previous year				
No	32%	REF	REF	REF
Yes	51%	**1.3*** (1.19 - 1.44)**	**1.32*** (1.24 - 1.4)**	**1.41 *** (1.31 - 1.5)**
Intentions to quit in next six-months				
No	35%	REF	REF	REF
Yes	51%	**1.75*** (1.42 - 2.15)**	**1.23*** (1.15 - 1.32)**	**1.26*** (1.18 - 1.36)**
Wave of Participation				
3	45%	REF	REF	REF
4	35%	**0.89* (0.8 - 0.99)**	0.9 (0.83 - 1.0)	**0.9* (0.82 - 1.0)**
5	35%	**0.9* (0.81 - 1.0)**	**0.84** (0.74 - 0.96)**	**0.8** (0.7 - 0.93)**

	Attempted to quit by follow-up period			
	Attempted to Quit n= 1,566 (38%)	**Bivariate Association RR (95% CI)**	**Adjusted Model-I RR (95% CI)**	**Adjusted Model-II RR (95% CI)**
Time-in-sample				
2	41%	REF	REF	REF
3	35%	0.92 (0.84 - 1.02)	1 (0.91 - 1.1)	1 (0.9 - 1.1)
4	37%	0.99 (0.88 - 1.1)	1.12 (0.97 - 1.29)	1.15 (0.99 - 1.34)

*** p<0.001, ** p<0.01, * p<0.05

Model-I: Adjusted model for association between exposure to SHS at workplaces and attempting to quit by follow-up period adjusting for type of ban, age, gender, education, income, wave of participation, & time-in-sample

Model-II: Adjusted model for association between exposure to SHS at hospitality industry venues and attempting to quit by follow-up period adjusting for type of ban, age, gender, education, income, wave of participation, & time-in-sample

Table 4.3 : Association between self-reported exposure to SHS at workplaces and hospitality industry venues and being quit by follow-up period

	Quit	Quit by follow-up period		
		Bivariate Association	Adjusted Model-I	Adjusted Model-II
	n= 536 (13%)	RR (95% CI)	RR (95% CI)	RR (95% CI)
Exposure to SHS at workplaces				
Not exposed to SHS	12%	REF	REF	
Not exposed to the workplace smoke-free policy	13%	0.89 (0.71 - 1.12)	0.91 (0.78 - 1.07)	**NA**
Exposed to SHS	15%	1.25 (0.83 - 1.89)	**1.37* (1.06 - 1.77)**	
Exposure to SHS at hospitality industry venues				
Not exposed to SHS	14%	REF		REF
Not exposed to the hospitality industry venue smoke-free policy	12%	1.02 (0.83 - 1.24)	**NA**	1.03 (0.84 - 1.26)
Exposed to SHS	14%	1.16 (0.91 - 1.48)		1.13 (0.89 - 1.44)
Type of Ban				
Partial	13%	REF	REF	REF
Comprehensive	13%	0.98 (0.76 - 1.26)	0.97 (0.82 - 1.16)	1.02 (0.85 - 1.17)
Smoking Intensity				
Non-daily	19%	**2.76*** (2.14 - 3.57)**	**2.7*** (2.23 - 3.26)**	**2.7*** (2.23 - 3.27)**
Daily-Light	13%	**1.62*** (1.23 - 2.13)**	**1.6*** (1.3 - 1.98)**	**1.61*** (1.3 - 1.99)**
Daily-Heavy	7%	REF	REF	REF

	Quit	Quit by follow-up period		
		Bivariate Association	Adjusted Model-I	Adjusted Model-II
	n= 536 (13%)	RR (95% CI)	RR (95% CI)	RR (95% CI)
Interactions				
Exposure to SHS at workplace * type of ban			0.514	
Exposure to SHS at workplace * smoking intensity			0.6882	**NA**
Exposure to SHS at hospitality industry venues * type of ban	**NA**	**NA**		0.3936
Exposure to SHS at hospitality industry venues * smoking intensity			**NA**	0.1468
Socio-demographics				
Age				
18 - 24	15%	REF	REF	REF
25 - 39	12%	0.79 (0.59 - 1.06)	**0.77** (0.63 - 0.93)**	**0.79* (0.65 - 0.97)**
40 - 54	11%	**0.71* (0.52 - 0.97)**	0.81 (0.65 - 1.0)	0.82 (0.66 - 1.02)
>54	15%	1.05 (0.79 - 1.44)	1.13 (0.88 - 1.44)	1.13 (0.88 - 1.5)
Gender				
Male	13%	REF	REF	REF
Female	13%	1.01 (0.81 - 1.24)	0.97 (0.83 - 1.12)	0.95 (0.82 - 1.1)

	Quit	Quit by follow-up period		
		Bivariate Association	Adjusted Model-I	Adjusted Model-II
	n= 536 (13%)	RR (95% CI)	RR (95% CI)	RR (95% CI)
Marital Status				
Married	13%	REF	REF	REF
Single	14%	1.06 (0.83 - 1.37)	1 (0.84 - 1.2)	1.01 (0.85 - 1.21)
Other	13%	1.09 (0.79 - 1.5)	1.18 (0.94 - 1.5)	1.18 (0.93 - 1.49)
Education				
Primary Education or less	13%	REF	REF	REF
Middle School	13%	1 (0.78 - 1.29)	1.03 (0.85 - 1.25)	1.02 (0.84 - 1.24)
Vocational school / HS / Incomplete University	11%	0.85 (0.65 - 1.13)	0.84 (0.68 - 1.04)	0.84 (0.67 - 1.04)
University & Postgraduate	17%	1.33 (0.94 - 1.87)	**1.44** (1.12 - 1.86)**	**1.45** (1.13 - 1.87)**
Income				
0 - 3,000	13%	REF	REF	REF
3,001 - 5,000	13%	1.01 (0.78 - 1.32)	1.08 (0.9 - 1.3)	1.09 (0.91 - 1.31)
5,001 - 8,000	12%	0.79 (0.58 - 1.07)	**0.77* (0.61 - 0.97)**	0.78 (0.62 - 0.99)
> 8,000	12%	0.96 (0.7 - 1.31)	0.9 (0.7 - 1.14)	0.91 (0.71 - 1.16)
Missing	16%	1.19 (0.83 - 1.7)	1.12 (0.87 - 1.45)	1.15 (0.89 - 1.5)
Attempted to quit in previous year				
No	11%	REF	REF	REF
Yes	16%	**1.54*** (1.27 - 1.88)**	**1.32*** (1.14 - 1.52)**	**1.32*** (1.14 - 1.53)**

	Quit	Quit by follow-up period		
		Bivariate Association	**Adjusted Model-I**	**Adjusted Model-II**
	n= 536 (13%)	**RR (95% CI)**	**RR (95% CI)**	**RR (95% CI)**
Intentions to quit in next six-months				
No	12%	REF	REF	REF
Yes	17%	**2.4*** (1.51 - 3.8)**	**1.36*** (1.16 - 1.59)**	**1.35*** (1.15 - 1.59)**
Wave of Participation				
3	16%	REF	REF	REF
4	12%	**0.76*** (0.6 - 0.95)**	0.88 (0.71 - 1.08)	0.87 (0.7 - 1.07)
5	11%	**0.71** (0.56 - 0.91)**	0.84 (0.62 - 1.13)	0.83 (0.62 - 1.12)
Time-in-sample				
2	14%	REF	REF	REF
3	12%	**0.79*** (0.63 - 0.98)**	0.89 (0.72 - 1.11)	0.9 (0.72 - 1.12)
4	11%	0.77 (0.58 - 1.02)	0.81 (0.58 - 1.13)	0.82 (0.59 - 1.15)

*** p<0.001, ** p<0.01, * p<0.05

Model-I: Adjusted model for association between exposure to SHS at workplaces and attempting to quit by follow-up period adjusting for type of ban, age, gender, education, income, wave of participation, & time-in-sample

Model-II: Adjusted model for association between exposure to SHS at hospitality industry venues and attempting to quit by follow-up period adjusting for type of ban, age, gender, education, income, wave of participation, & time-in-sample

CHAPTER 5

Socio-demographic and smoking-related differences in trajectories of responses to health warning labels on cigarette packages over time: Results from a panel of Mexican smokers.

5.1: INTRODUCTION:

The World Health Organization's (WHO) Framework Convention on Tobacco Control (FCTC) includes the guiding principle that "every person should be informed of the health consequences, addictive nature, and mortal threat posed by tobacco consumption and exposure to tobacco smoke" (1). This principle underlies Article 11 of the FCTC, which stipulates that within three years of treaty ratification, countries should implement prominent pictorial health warning labels (HWLs) on cigarette packs. These warning labels "should be 50% or more of the principle display areas but shall be no less than 30% of the principle display areas" and "should be in the form of or use pictures or pictograms" (1). By 2014, 77 countries adopted pictorial HWLs; more than 49% of the world's population is now exposed to pictorial HWLs on cigarettes (219). Two HWL rotation strategies are suggested in the Article 11 of the FCTC guidelines (178): " *(1) having multiple health warnings and messages appearing concurrently or (2) by setting a date after which the health warning and message content will change."* FCTC recommends parties to consider using both types of rotation. These guidelines imply

that the same HWLs will not remain effective over longer periods of time, suggesting that the effectiveness of HWLs will "wearout".

Most of the evidence for effectiveness of HWLs over time comes from high-income countries (HICs), indicating that large and more prominent warnings are more effective over time than less prominent HWLs. Furthermore, HWLs have their greatest impact shortly after initial implementation, and this effectiveness declines over time (9, 10, 155, 181). Declines in impact appear greater for noticing and reading HWLs (i.e., attention to HWLs) than for cessation-related cognitive responses (e.g., HWLs lead smokers to think about health risks of smoking), and behavioral responses (e.g., smokers delay having a cigarette due to HWLs). These cognitive and behavioral responses to HWLs, but not salience of HWLs, have been shown to have an independent predictive power for making subsequent quit attempts (182).

The limited evidence from population-based studies in LMICs shows similar results for the effectiveness of pictorial HWLs in comparison to text-only warning labels (220-222). To our knowledge, only two studies have attempted to understand the wearout effects in LMICs (220, 222). A study conducted in Mauritius evaluated the impact of its newly implemented pictorial HWLs that cover 60% of the front and 70% of the back of cigarette pack with a set of eight rotating messages. Six months prior to policy data was compared with 10months and 20months post-policy data. This study found that the salience, cognitive and behavioral responses to HWLs increased greatly immediately following the implementation of pictorial HWLs but these measures reduced over time suggesting wearout (220). Another study conducted in Thailand

found that refreshing the pictorial HWL content about 2-years after the initial implementation resulted in sustaining the cognitive and behavioral responses to HWL even after 3-years of initial policy implementation (222).

Prior research on the correlates of HWL responses has shown that disadvantaged populations may differ in their ability to access, process and act on health information leading to "communication inequality" (162, 163). In most countries, smoking is disproportionately concentrated in low SES groups (167). Pictorial HWLs on cigarette packages are the most cost-effective forms of health communications for tobacco control that are equally likely to reach low SES groups. HWLs are printed directly on the product packaging, leading to broader reach, which results in higher levels of awareness of smoking risks across different SES groups (168). Research shows that for text-only warnings, greater disparities in health knowledge across educational levels were observed while these disparities were not present for pictorial HWLs (148, 165). There have been some experimental studies that compared the effectiveness of text-only and pictorial HWLs (156, 169, 170). These studies found that across the education groups, pictorial HWLs were more likely to be noticed and read, and were perceived as more credible, having higher impact, and increasing smokers' motivations to quit. Compared to the smokers with high education, low-education smokers were more likely to rate pictorial warnings as more effective (156, 170). The results of experimental studies, however, should be considered in context as the participants view a series of warnings for a brief amount of time and then rate them. This does not replicate the real-life scenario where a population will be repeatedly exposed to HWLs. The limited data from

population-based studies also suggest that HWLs may be more effective among lower education groups (171-173). A study compared the impact of HWLs in three Latin American countries: Brazil with graphic imagery, Uruguay with abstract pictorial representations of risk and Mexico with text-only messages (173). This study found that smokers with higher education were more likely to notice and read Mexico's text-only HWLs, while there was no association between education and noticing pictorial HWLs of Brazil and Uruguay. However, smokers with lower education in Brazil were more likely than smokers with higher education to think about smoking-related risks and quitting due to HWLs. This inverse association of education and impact of HWLs was not present in Mexico, suggesting that compared to text-only warnings, pictorial warning labels do a better job of communicating smoking risks among lower educational groups. The limited experimental and population-based studies suggested that compared to high-income smokers, low-income smokers are more likely to perceive pictorial HWLs as more effective (169, 171).

The effectiveness of HWLs across different smoking intensity groups (non-daily smokers - who don't smoke daily; low-intensity smokers – who consume fewer cigarettes per day; high-intensity smokers) is another understudied area of research. Smoking intensity is the most consistent predictor of cessation behavior. The limited research in this area shows that in general, non-daily and low-intensity smokers had stronger responses to HWLs compared to heavy smokers(172, 173, 177). In several low- and middle-income countries (LMICs), non-daily and low-intensity smoking are the predominant smoking patterns, in contrast to smoking patterns in HICs (223). There

have been no studies that compared the effectiveness of HWL over time by smoking intensity groups.

To our knowledge, there have been no studies that systematically evaluated the effectiveness of HWLs over time across various socio-demographic groups and smoking-related factors. Given that LMICs have lower literacy and lower levels of readily available health information about the risks of smoking, the benefits of pictorial HWLs might even be greater. So it is important to understand the effectiveness of HWLs across the population sub-groups and any differential wearout of the HWLs. The current HWLs implementation strategy in Mexico provides an excellent opportunity to examine differential wearout effects of HWLs that are implemented as per the FCTC recommended rotation strategy, i.e., having multiple health warning messages appearing concurrently and health warning content changing periodically.

Context in Mexico:

In 2004, the warning labels in Mexico were increased to 50% of the backside of cigarette packages, with three rotating messages in the warning label area and the message “Currently there are no cigarettes that reduce health risks” on the side of every cigarette pack. There were no warnings on the front of the pack. In May of 2008, the Mexican President signed the General Tobacco Control Law (GLTC) that included adoption of pictorial HWLs (183). Articles 18 to 22 of GLTC state that the health warnings be placed on 30% of the front (location of the pictogram) and 100% of the side and back (to include the content, emissions, risks and health damage, and the telephone helpline for smoking cessation) on the cigarette package. Under these new regulations,

four new HWLs are introduced every 6months, making it the fastest rotation of HWLs in the world. Since the time pictorial HWLs were first implemented in 2010, a total of five sets of HWLs were introduced through 2014.

Using the first six waves of data from the Mexico administration of the "Wearout" study data, we aim 1) to examine HWL responses over time and 2) to assess the socio-demographic and smoking-related differences in the HWL responses at baseline and over time. We hypothesize that the salience of HWLs reduces over time and cessation-related cognitive and behavioral responses do not reduce over time as new HWL content is introduced every 6months. We also hypothesize that, 1) compared to higher socio-economic groups, lower socio-economic groups will have greater responses to HWLs at baseline and that their responses to HWLs will reduce at a slower rate over time; and 2) compared to daily-heavy smokers, non-daily and daily light smokers will have greater responses to HWLs. Previous research that looked at the responses to HWLs over time used data from longer duration of follow-ups (around one to one and half years)(9, 10, 155, 181, 220, 222). To our knowledge, ours is the first study to examine the changes in HWL responses over time. Also, the short follow-up period, 4-month interval, in our study allows for more nuanced examination of HWL response trajectories to rule out the influence of any intervening variables.

5.2: METHODS

Study Setting and Population:

Data comes from the Mexican administration of the "Warning Wearout" project. The objective of this project is to assess pictorial warning label impacts and their

wearout among adult smokers in Australia, Canada, Mexico, and the US, and to inform policy development around future warning label content, design, size and rotation frequency. Online consumer panels of adult smokers from Mexico were invited to participate in the study. At entry into the study, eligible participants were 18 to 64 years of age, had smoked at least 100 cigarettes in their lifetime, and smoked at least once in the month prior to study enrollment. Six waves of data were collected at four-month intervals (September 2012; January – February 2013; May - June 2013; October – November 2013; April – May 2014; and September – October 2014). To address attrition and maintain sample sizes of 1,000 participants at each wave, samples were replenished at each wave with new participants who met study eligibility criteria. For the current study, data from 3,366 participants were analyzed.

Measurements:

Responses to HWLs:

Three measures of responses to HWLs were considered in this study: (i) attention to HWLs, (ii) cognitive responses to HWLs and (iii) behavioral responses to HWLs. The cognitive and behavioral responses to HWLs used in this study have been shown to predict quit attempts among Australian and Canadian smokers (182, 224). Also, a study conducted in Guadalajara, Mexico, found that the newly implemented pictorial HWLs in Mexico were associated with these psychosocial and behavioral responses (225).

Attention to HWLs was measured from smoker's response to the following questions: "*In the last month, how often, if at all, have you noticed health warnings on cigarette packages*?" and "*In the last month, how often, if at all, have you read or looked closely*

at the warning labels on cigarette packages?" Response options were on a range of 1-5 scale: 1= "never", 2="rarely", 3="sometimes", 4="often", 5="very often", and "don't know." "Don't know" category was recoded to missing and notice and read measures were averaged to create attention to HWLs ranging from 1 to 5.

Cognitive responses to HWLs were created by combining three correlated items (Cronbach's alpha = 0.91) that assessed cessation-related outcome expectancies. These three items were measured from smoker's response to following questions: *"To what extent do the warning labels make you think about the health risks of smoking?"; "To what extent do the warning labels on cigarette packs make you more likely to quit smoking?";* and *"How much do the warning labels make you feel like you would be better off without smoking?"* This third item addressing positive outcome expectancies has not been evaluated in previous HWL research (155). The response options for these three items include 9-point scales with verbal anchors for every other response option (i. e., "not at all", "a little", "moderately", "very much", and "extremely" and a separate category for "don't know"). An average of these three items was used to measure cognitive responses to HWLs.

Behavioral response to HWLs was measured from smokers' responses to the following question: *"In the last month, have the warning labels stopped you from having a cigarette when you were about to smoke one?"*, with response options – "never", "once", "a few times", "many times" and "don't know". The "don't know" category was recoded to missing and remaining options were recoded to "never" versus "at least once."

Covariates:

Smoking intensity was determined by asking participants to report daily or non-daily smoking, as well as the average number of cigarettes they smoked on the days that they smoked. Smokers were classified as non-daily smokers (i.e., those that did not smoke every day but at least once in the past 30 days), daily light (smoking <= 5 CPD), and daily heavy (smoking > 5 CPD). These categories generally reflect tertiles of consumption intensity among the Mexican smoking population, but are also informed by previous research that has considered the low level of smoking among Latinos (29). Quit intentions were assessed by asking whether participants planned to quit in the next month, in the next six months, sometime beyond six months, or not at all, with responses dichotomized to indicate intention to quit within the next six months vs. not. Age (18-24 years, 25-34 years, 35-44 years, 45-54 years & 55-64 years), gender (male vs. female), education (less than high school, some college & university or more) and income (low, medium & high) were the socio-demographic factors considered in the analysis.

Analysis:

All analyses were performed in MPlus 7.1 version. Latent Growth Curve (LGC) models (226) were employed to examine the changes in responses to HWLs over time and to identify the correlates of these changes. LGC analyses create a regression line for each of the three HWL responses over time, estimating two latent factors that represent baseline HWL response (intercept) and change in HWL response over time (slope). Three alternative models – no growth, linear and nonlinear (quadratic) – were compared to

determine the best way to characterize the trajectories of HWL responses. Socio-demographic and smoking-related variables were then added as time-invariant and time-variant predictors of these HWL growth curves, respectively. Time-invariant predictors vary across smokers but not across time and these factors explain the variation in HWL response growth factors, i.e., intercept and slope. Time-varying predictors vary across both smokers and time explaining the variation in HWL response indicators.

Figure 1 displays the latent growth curve model that was utilized for all the three HWL responses. HWL responses corresponding to all the six waves of data are listed from left to right across the top of the figure. To represent baseline HWL response, an intercept factor was created with a fixed loading of 1.0 to HWL response at each wave. Slope factors were fixed to represent the expected pattern of change over the study time period as follows: 0, 0, 0, 0, 0 (no growth); 0, 1, 2, 3, 4,5 (linear); 0, 1, 4, 9, 16, 25 (quadratic) to each respective wave of HWL response. The adequacy of model fit was assessed by the chi-square statistic or discrepancy function and with approximate fit indices such as the comparative fit index and Tucker-Lewis index (CFI and TLI) (227), and the root mean squared error of approximation (RMSEA) (228). Acceptable model fit was indicated by a value greater than 0.95 on CFI, TLI and a value less than 0.05 on the RMSEA. For all the three HWL responses, unconditional linear growth curve models were best fitting and hence the linear growth curve models were considered in subsequent models that integrated the time-invariant and time-varying covariates.

Three models were analyzed for each of the HWL responses. The first LGC models (i.e., unconditional LGC model) examined the trajectory of HWL response containing only the intercept and slope factors and HWL response indicators. The second LGC model, bivariate model that has one predictor at a time, included either each of the time-invariant variables (age, gender, education and income) as direct predictors of the intercept and slope of trajectory or each of the time-varying variables (smoking-intensity and intentions to quit in next 6months) as direct predictors of their concurrent wave and subsequent follow-up wave HWL response indicator variables. The third, fully adjusted LGC model included all the time-invariant and time-variant variables.

For time-invariant covariates, in bivariate models, Wald-tests were conducted to assess whether there was an influence of each covariate on intercept and slope parameters. Statistically significant Wald-tests at $\alpha<0.05$ indicated influence of covariate either on the intercept, the slope, or both. Wald-tests were also conducted to assess whether time-varying covariates influenced HWL response indicator variables at both concurrent wave and the subsequent wave of follow-up including tests of whether the influence of each of the time-varying covariates on HWL responses was the same across the waves or not. None of the Wald tests were statistically significant for influence of time-varying covariates on HWL response indicator variables at subsequent follow-up waves. Also, the influence of time-varying covariates on HWL responses at the concurrent wave was same across all the waves. Hence the models were constrained to

have only concurrent wave influences and also to have the same influence of time-varying covariate on HWL response indicator variables.

Missing data: The percentage of missing values for socio-demographic variables ranged from 0% (age, gender, education) to 5% (income) and for smoking-related variables and responses to HWLs, missing values ranged from 0% to 8%. Respondents with missing data were retained in order to preserve a representative sample of smokers and to minimize nonresponse bias. Of the smokers who participated up to wave-V (n=2,930), 56% were lost to follow-up with no additional wave of data. About 20% of smokers participated in two waves, 11% in three waves, 5% in four waves, 3% in five waves and 4% of smokers participated in all six waves of data. Missing data were estimated using full-information maximum likelihood in MPlus so that data from all the cases were included in the analyses. Given that more than half of our sample did not have follow-up data, we ran sensitivity analyses to examine if the pattern of the results was same by including only smokers that had at least one wave of follow-up data. In general, the direction and significance of results remained the same. In the full-models to avoid the issue of list-wise deletion, smoking intensity variable was entered as a continuous variable instead of the three-level variable used in the bivariate models.

5.3: RESULTS:

Descriptive Characteristics

The analytic sample (N = 3,366) included all adult smokers who participated in any of the six waves of data collection. Table 1 presents the socio-demographic and smoking-related characteristics of the analytic sample. About half of our sample was

>35 years of age, completed university degree or higher, had income higher than $10,000 per month, did not smoke every day, attempted to quit at least once in previous 4months and were intending to quit in the next 6months.

Table 2 presents the descriptive statistics of HWL responses by each wave of data collection and the mean and variance of trajectory parameters, i.e., intercept and slope. For attention to HWLs and cognitive responses to HWLs, the mean of the intercept represents the baseline value. Positive rate of change (slope) values indicated that the HWL responses increased over time whereas negative values for slope indicated that the HWL responses decreased over time. Since behavioral response to HWLs was a dichotomous variable, a negative slope for behavioral response indicated that behavioral responses increased over time.

Attention to HWLs Salience

In unconditional model, the mean value for the intercept was statistical significantly greater than '0' (mean=3.4, $p<0.001$) and there was statistically significant between-person variability in the intercept ($p<0.001$) (Table 2). The negative slope indicated that the attention to HWLs statistical significantly reduced over time (b=-0.06, $p<0.001$). There was statistical significant between-person variability for the slope of attention to HWLs ($p<0.01$).

Table 3 shows the results from the bivariate and adjusted models for the trajectory of attention to HWLs. When estimating the bivariate influence of socio-demographics on the intercept, compared to the 18-24 year old smokers, 45-54 year olds were less likely to report attention to HWLs (b=-0.178, p=0.038), and compared to

males, females were more likely to report attention to HWLs (estimate: 0.133; p=0.008).There were no statistically significant differences in intercept across the education and income groups. Also, in bivariate models there were no statistically significant socio-demographic differences in slopes. In bivariate models for time-varying predictors, daily smokers consuming <= 5 CPD were more likely to report attention to HWLs in comparison to non-daily smokers (b=0.084; p-value=0.027) when predicting attention to HWLs at the concurrent wave. In the fully adjusted models, greater to attention to HWLs among females compared to males remained statistically significant (b=0.202, p-value<0.001). In fully adjusted models, neither smoking intensity nor intentions to quit in the next 6months were statistically significant predictors of attention to HWLs at concurrent wave.

Cognitive Responses to HWLs

In unconditional model, the mean value for the intercept of cognitive responses to the HWLs was statistical significantly greater than '0' (mean=5.4, p<0.001) and there was statistically significant between-person variability in the intercept (p<0.001) (Table 2). The positive slope indicated that the cognitive responses to HWLs statistical significantly increased over time (b=0.06, p<0.001). There was statistically significant between-person variability for slope of cognitive responses to HWLs (p<0.01).

Table 4 shows the results from bivariate and adjusted models for the trajectory of HWL cognitive responses. When estimating the bivariate influence of socio-demographics on the intercept, 25-34 and 35-44 year old smokers reported stronger cognitive response to HWLs when compared to the 18-24 year old smokers (b=0.295, p-

value=0.043 and b=0.483, p-value=0.003 respectively). Compared to smokers with high school education or less, smokers who completed a university degree reported weaker cognitive responses to HWLs (b=0.267; p-value 0.02). In bivariate models there were no statistically significant socio-demographic differences in slope of cognitive responses to HWLs. In bivariate models for time-varying predictors, daily smokers consuming > 5 CPD reported weaker cognitive responses to HWLs at the concurrent wave in comparison to non-daily smokers (b=-0.366; p-value<0.001), and smokers who intended to quit in the next 6months reported stronger cognitive responses to HWLs at the concurrent wave compared to smokers with no intentions to quit in the next 6months (b=0.289, p-value<0.0001). In fully adjusted models, stronger cognitive responses to HWLs at baseline among the 35-44 year olds remained statistically significant (b=435, p=0.036). There were no socio-demographic differences in the slope of cognitive responses to HWLs. Stronger cognitive responses to HWLs at the concurrent wave among smokers who intended to quit in the next 6months remained statistically significant (b=0.21, p=0.045).

Behavioral Response to HWLs

In unconditional model, the negative slope indicate that the behavioral responses to HWLs statistical significantly increased over time (b=-0.15, p=0.007) (Table 2). There was no statistically significant between-person variability for slope of behavioral response to HWLs (p=0.394).

Table 5 shows the results from bivariate and adjusted models for the trajectory of behavioral responses to HWLs. When estimating the bivariate influence of socio-

demographics on the intercept, smokers of 45-54 and 55-64 years of age were less likely to report behavioral responses to HWLs compared to smokers of 18-24 years of age (b= -0.24, p-value=0.041 & b= -0.274, p-value=0.02 respectively). Compared to smokers in the low income category, smokers in the high income category were less likely to report behavioral responses to HWLs (b=-0.278, p-value = 0.001). In bivariate models there were no statistically significant socio-demographic differences in the slope of behavioral responses to HWLs. In bivariate models for time-varying predictors, daily smokers consuming <= 5 CPD and > 5 CPD were less likely to report behavioral responses to HWLs at the concurrent wave when compared to non-daily smokers (b=-0.273, p-value<0.001 and b=-0.504, p<0.001, respectively). In fully adjusted models, less frequent behavioral responses to HWLs among the high income smokers remained statistically significant (b=-0.411, p=0.04). The change in behavioral responses over time increased less dramatically amongst smokers with some college education compared to smokers with high school education or less(b=-0.176; p-value=0.016). Also, compared to non-daily smokers, daily smokers were less likely to report behavioral responses to HWLs at concurrent wave (b= -0.666, p-value=0.019). There were no other statistically significant socio-demographic differences in the intercept or slope for the behavioral response to HWLs. Also, intending to quit in the next 6months was not associated with the behavioral responses to HWLs at the concurrent wave.

5.4: DISCUSSION:

Our results indicated that after two-years of implementing pictorial HWLs in Mexico, attention to HWLs declined over the study period, while the cessation-related

cognitive and behavioral responses to HWLs continued to increase over time. The finding of attention to HWLs declining over time was similar to previous studies conducted in HICs such as Canada, Australia and UK (10, 155, 181), as well as LMICs, including Thailand (222), Mexico (229), Mauritius (220) and Malaysia (230). Most of the previous studies found that after a few years of implementing pictorial HWLs, even the cognitive and behavioral responses to HWLs declined suggesting "wearout" of the HWLs (10, 155, 181, 220). However, one study conducted in Thailand found that cognitive and behavioral responses to HWLs were sustained after new pictorial HWL content was introduced (222), as we found here. The frequent introduction of new HWL content (i.e., every 6 months) in Mexico, may explain these findings, although attention to HWLs declined over time. Further research is necessary to examine the effectiveness of different strategies for rotating and refreshing the HWL content by comparing jurisdictions.

Our study results are in line with prior experimental and observational research indicating that responses to pictorial HWLs are not weaker among low SES smokers, and there is some indication that some of the HWL responses were stronger in low SES groups (171-173). Compared to smokers with lower education, more highly educated smokers reported weaker cognitive responses to HWLs at baseline and they reported less frequent behavioral responses to HWLs over time. Compared to low-income smokers, high-income smokers reported less frequent behavioral responses to HWLs. A survey conducted in Mexico before implementation of pictorial HWLs found that education was the only demographic factor that predicted adults' knowledge of smoking

effects (165). Adults with high levels of education (university degree or higher) reported greater levels of health knowledge compared with those with low (primary, middle, or technical/vocational school) or moderate (high school or some university) levels of education. Our study results for the cognitive responses suggest pictorial HWLs in Mexico may help reduce the inequalities in knowledge of smoking-related risks. These results also extend our understanding about the effectiveness of pictorial HWLs over time among low SES groups - a hard to reach group for many intervention efforts. Future studies are needed to understand whether pictorial HWLs result in different rates of quit success across these groups.

At baseline, compared to males, females were more likely to report attention to HWLs. However, there were no gender differences in attention to HWLs over time. This might reflect a general tendency of females to respond more strongly to health information (16, 109). We did not find any gender differences for cognitive responses to HWLs or behavioral responses to HWLs. Our bivariate models suggested that at baseline, compared to smokers of younger age, smokers of middle age reported less attention to HWLs, stronger cognitive responses to HWLs and less frequent behavioral responses to HWLs. These finding are not entirely consistent with previous literature that has found younger group smokers to report greater attention to HWLS, stronger cognitive and behavioral responses to HWLs than older group smokers (172, 173). However, the statistically significant bivariate associations in our study were attenuated in adjusted models suggesting confounding by the covariates.

Our results indicate that non-daily smokers were no less likely to report attention or cognitive or behavioral responses to HWLs. In fact, higher cigarette consumption was associated with weaker cognitive and behavioral responses. These findings indicate that even smokers with less frequent exposure to cigarette packages are equally likely, if not more likely, to report cessation-related responses to HWLs. This finding is important especially given that there has been concern about the effectiveness of HWLs among low-intensity smokers in Mexico who are more likely to buy and smoke single cigarettes and hence less likely to be exposed to the HWLs on cigarette packages (231). In addition, previous research shows that in Mexico, compared to daily smokers, non-daily smokers were less likely to report awareness of quit lines because of HWLs (232). The quitline information is provided on the back of the pack along with other text-only warnings. During the cigarette purchase, a single-cigarette smoker might be less likely to see the text message on the back of packs. Our results also indicated that smokers who intended to quit in the next 6months were more likely to report stronger cognitive responses to HWLs. We did not find an association between intention to quit in the next 6months and attention to HWLs or behavioral responses to HWLs.

Our study has several limitations. All the measures used in the study were self-reported. Self-reported measures are prone to social desirability bias such that smokers might have over-reported their responses to HWLs. However, this may not affect the slopes of HWL responses and hence our results. Study data were collected from online panels of consumers with no clearly defined sampling frame limiting generalizability of

our results. The internet penetration in Mexico is only 37% according to 2013 estimates (233). Compared to the general Mexican population, the sample in this study has higher average income and education resulting in possible selection bias. In fact, other studies conducted among Mexican smokers show that compared to smokers with lower educational attainment, smokers with higher educational attainment have weaker responses to HWLs (221, 225). By having fewer low-education participants, our study might have been under-powered to detect education-related differences and the point estimates may have been underestimated. About 50% of our sample had only one wave of data. This lack of follow-up data might have limited our ability to find predictors of the slope parameter.

To our knowledge, this is the first study to examine the impact of HWLs over time using data from short follow-up periods (i.e., 4-month interval) and also to examine the responses to HWLS over time across population sub-groups. Our study results suggest that over time, the attention to HWLs is declining in Mexico, but that cessation-related cognitive and behavioral responses to HWLs are increasing. Also, over time, HWLs in Mexico appear to be equally effective across socio-economic groups and for some measures, more effective among low SES groups than the high SES groups.

Table 5.1: Characteristics of analytic sample

Socio-demographic and Smoking-related characteristics of interest	Mexico Waves-I to VI ($N_{smokers}$ = 3,366)	
	n	%
Age		
18 - 24 years	754	22%
25 - 34 years	978	29%
35 - 44 years	675	20%
45 - 54 years	557	17%
55 - 64 years	402	12%
Gender		
Female	1534	46%
Education		
High school or less	1127	33%
College or some university	713	21%
Completed university or higher	1526	45%
Income[#]		
Low	603	19%
Middle	846	27%
High	1744	55%
Smoking Intensity		
Non-daily	1683	50%
Daily <= 5 CPD	572	17%
Daily > 5 CPD	1111	33%
Quit attempts in previous 4-months		
Yes	1784	53%
Quit intentions in next six-months		
Yes	1552	46%
Wave entered into the study		
Wave-I	1010	30%
Wave-II	505	15%
Wave-III	471	14%
Wave-IV	505	15%
Wave-V	438	13%
Wave-VI	438	13%

[#] Income categories are Low=$0-$5,000, middle=$5,001-$10,000, high=$10,001 or more

Table 5.2: Descriptive Statistics and Trajectory Parameters (Intercept & slope) for HWL responses

HWL Responses of Interest	Wave-I	Wave-II	Wave-III	Wave-IV	Wave-V	Wave-VI	Intercept		Slope	
							Mean (p-value)	Variance (p-value)	Mean (p-value)	Variance (p-value)
Attention to HWLs (Mean (STD))*	3.3 (1.03)	3.3 (1.07)	3.2 (1.06)	3.2 (1.05)	3.13 (1.07)	3.06 (1.02)	3.4 (<0.001)	0.58 (<0.001)	-0.06 (<0.001)	0.02 (<0.001)
Cognitive responses to HWLs (Mean (STD))**	5.4 (2.19)	5.72 (2.13)	5.57 (2.24)	5.65 (2.15)	5.5 (2.2)	5.7 (2.2)	5.4 (<0.0001)	3.4 (<0.001)	0.06 (<0.001)	0.05 (<0.001)
Behavioral response to HWLs - Once or more (%)	38%	40%	43%	46%	41%	44%	-	-	-0.15 (0.007)	0.005 (0.394)

*Attention to HWLs - 1 to 5 Scale

**Cognitive responses to HWLs - 1 to 9 Scale

Table 5.3: Latent growth curve model estimates for Attention to HWLs

	Bivariate Model			Adjusted Model	
		Influence on Latent Curve		Influence on Latent Curve	
	Wald Test	**Intercept**	**Slope**	**Intercept**	**Slope**
	Est (df) (p-value)	**Est (p-value)**	**Est (p-value)**	**Est (p-value)**	**Est (p-value)**
Time-invariant predictors					
Age	15.2 (8) 0.0554				
18-24		**REF**	**REF**	**REF**	**REF**
25-34		-0.029 (0.686)	0.018 (0.443)	-0.06 (0.461)	0.019 (0.476)
35-44		-0.002 (0.984)	0.01 (0.67)	0.004 (0.965)	-0.001 (0.967)
45-54		**-0.178 (0.038)**	0.036 (0.169)	-0.206 (0.085)	0.028 (0.34)
55-64		-0.132 (0.126)	-0.007 (0.803)	-0.104 (0.429)	-0.016 (0.627)
Education	6.6 (4) 0.1584				
High school or less		**REF**	**REF**	**REF**	**REF**
some College or University		-0.013 (0.85)	-0.033 (0.153)	-0.062 (0.415)	-0.026 (0.296)
University or more		0.048 (0.402)	-0.031 (0.093)	-0.029 (0.662)	-0.029 (0.163)
Gender	**13.17 (2) 0.0014**				
Male		**REF**	**REF**	**REF**	**REF**
Female		**0.133 (0.008)**	-0.005 (0.0732)	**0.202 (<0.0001)**	-0.022 (0.193)

	Bivariate Model			Adjusted Model	
		Influence on Latent Curve		Influence on Latent Curve	
	Wald Test Est (df) (p-value)	Intercept Est (p-value)	Slope Est (p-value)	Intercept Est (p-value)	Slope Est (p-value)
Income	3.525 (4) 0.4741				
Low		**REF**	**REF**	**REF**	**REF**
Middle		-0.045 (0.532)	0.038 (0.108)	-0.047 (0.556)	0.04 (0.12)
High		-0.007 (0.91)	0.02 (0.301)	-0.001 (0.983)	0.044 (0.06)
Time-varying predictors		**Influence on Attention to HWLs at concurrent wave Est (p-value)**		**Influence on Attention to HWLs at concurrent wave Est (p-value)**	
Smoking Intensity				-0.048 (0.603)	
Non-daily		**REF**			
Daily <=5 CPD		**0.084 (0.027)**			
Daily > 5 CPD		0.049 (0.171)			
Quit Intentions					
Yes vs NO		0.035 (0.433)		0.049 (0.347)	

Table 5.4: Latent growth curve model estimates for Cognitive reactions to HWLs

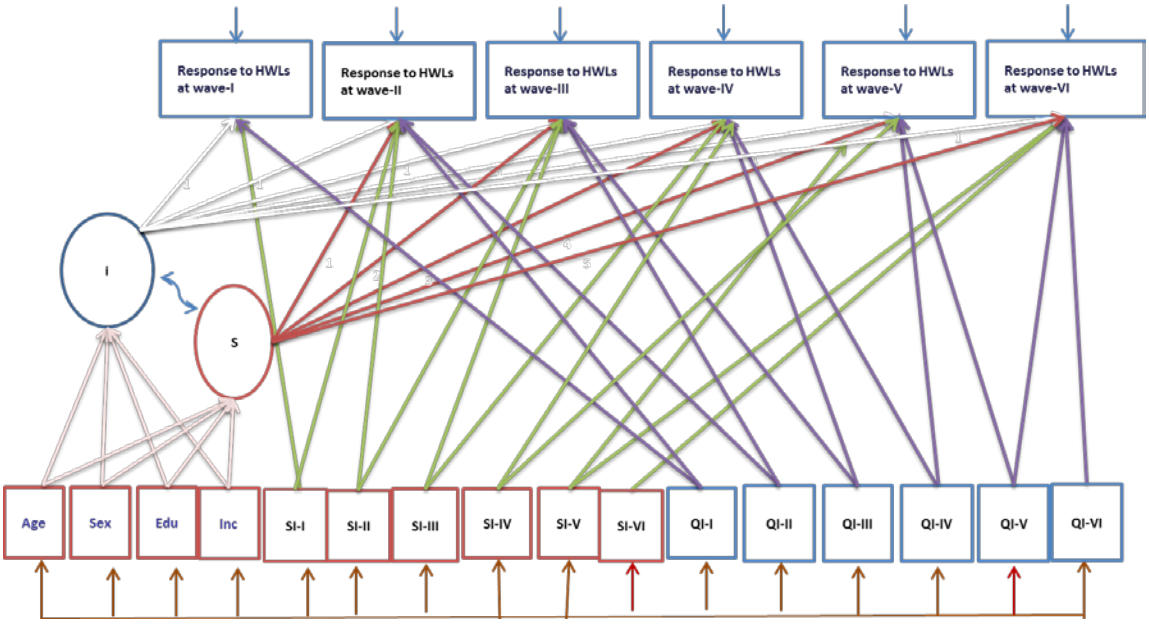
	Bivariate Model			Adjusted Model	
		Influence on Latent Curve		Influence on Latent Curve	
	Wald Test	Intercept	Slope	Intercept	Slope
	Est (df) (p-value)	Est (p-value)	Est (p-value)	Est (p-value)	Est (p-value)
Time-invariant predictors					
Age	**18.56 (8) (0.0174)**				
18-24		**REF**	**REF**	**REF**	**REF**
25-34		**0.295 (0.043)**	-0.039 (0.382)	0.312 (0.075)	-0.034 (0.539)
35-44		**0.483 (0.003)**	-0.026 (0.58)	**0.435 (0.036)**	-0.024 (0.682)
45-54		0.117 (0.499)	0.016 (0.761)	0.126 (0.621)	0.005 (0.934)
55-64		0.331 (0.059)	-0.085 (0.12)	0.247 (0.367)	-0.059 (0.359)
Education	**34.094 (4) (<0.0001)**				
High school or less		**REF**	**REF**	**REF**	**REF**
some College or University		-0.275 (0.05)	-0.084 (0.057)	-0.133 (0.419)	-0.099 (0.064)
University or more		**-0.267 (0.02)**	-0.062 (0.08)	-0.192 (0.172)	-0.085 (0.064)
Gender	0.302 (2) (0.8598)				
Male		**REF**	**REF**	**REF**	**REF**
Female		0.047 (0.644)	-0.004 (0.908)	0.069 (0.561)	0.001 (0.977)

	Bivariate Model			Adjusted Model	
		Influence on Latent Curve			Influence on Latent Curve
	Wald Test	Intercept	Slope	Intercept	Slope
	Est (df) (p-value)	Est (p-value)	Est (p-value)	Est (p-value)	Est (p-value)
Income	**11.27 (4) (0.0237)**				
Low		**REF**	**REF**	**REF**	**REF**
Middle		0.248 (0.089)	-0.048 (0.302)	0.202 (0.235)	-0.014 (0.803)
High		-0.031 (0.808)	-0.045 (0.264)	0.001 (0.994)	0.004 (0.937)
Time-varying predictors		**Influence on cognitive reactions to HWLs at concurrent wave Est (p-value)**		**Influence on cognitive reactions to HWLs at concurrent wave Est (p-value)**	
Smoking Intensity				-0.067 (0.737)	
Non-daily		**REF**			
Daily <=5 CPD		0.122 (0.104)			
Daily > 5 CPD		**-0.366 (<0.0001)**			
Quit Intentions					
Yes vs NO		**0.289 (<0.0001)**		**0.21 (0.045)**	

Table 5.5: Latent growth curve model estimates for behavioral responses to HWLs

	Bivariate Model			Adjusted Model	
	Influence on Latent Curve			Influence on Latent Curve	
	Wald Test	**Intercept**	**Slope**	**Intercept**	**Slope**
	Est (df) (p-value)	**Est (p-value)**	**Est (p-value)**	**Est (p-value)**	**Est (p-value)**
Time-invariant predictors					
Age	**25.922 (8) (0.0011)**				
18-24		**REF**	**REF**	**REF**	**REF**
25-34		-0.068 (0.487)	0.023 (0.455)	0.069 (0.764)	0.035 (0.643)
35-44		-0.085 (0.427)	0.023 (0.489	0.213 (0.431)	0.013 (0.864)
45-54		**-0.24 (0.041)**	0.009 (0.806)	0.199 (0.542)	-0.046 (0.591)
55-64		**-0.274 (0.02)**	-0.016 (0.677)	0.259 (0.481)	-0.063 (0.505)
Education	**10.595 (4) (0.0315)**				
High school or less		**REF**	**REF**	**REF**	**REF**
some College or University		0.032 (0.73)	-0.059 (0.056)	0.192 (0.364)	**-0.176 (0.016)**
University or more		-0.101 (0.191)	0.02 (0.411)	-0.129 (0.479)	0.024 (0.691)
Gender	0.721 (2) (0.6973)				
Male		**REF**	**REF**	**REF**	**REF**
Female		-0.011 (0.874)	0.014 (0.498)	-0.043 (0.784)	0.016 (0.737)

	Bivariate Model			Adjusted Model	
	Influence on Latent Curve			Influence on Latent Curve	
	Wald Test	Intercept	Slope	Intercept	Slope
	Est (df) (p-value)	Est (p-value)	Est (p-value)	Est (p-value)	Est (p-value)
Income	**15.481 (4) (0.0038)**				
Low		**REF**	**REF**	**REF**	**REF**
Middle		-0.121 (0.195)	0.02 (0.535)	-0.429 (0.056)	0.077 (0.299)
High		**-0.278 (0.001)**	0.032 (0.225)	**-0.411 (0.04)**	0.067 (0.322)
Time-varying predictors		**Influence on behavioral responses to HWLs at concurrent wave Est (p-value)**		**Influence on behavioral responses to HWLs at concurrent wave Est (p-value)**	
Smoking Intensity				**-0.666 (0.019)**	
Non-daily		**REF**			
Daily <=5 CPD		**-0.273 (<0.0001)**			
Daily > 5 CPD		**-0.504 (<0.0001)**			
Quit Intentions					
Yes vs NO		0.026 (0.742)		0.208 (0.156)	



I: intercept; S: Slope;
SI-I to SI-VI – Smoking intensity at each time-point (wave-I to VI)
QI-I to QI-VI – Quit Intentions at each time-point (wave-I to VI)
Responses to HWLs include attention, cognitive responses and behavioral responses

Figure 5.1: Latent growth curve model showing the contribution of socio-demographic and smoking-related variables on their responses to HWLs

CHAPTER 6

Summary

Summary of findings from Chapters 3-5

The purpose of this dissertation was to understand changes in smoking consumption patterns, factors that are associated with changes in smoking consumption, and the impact of smoke-free policies and pictorial HWLs across different smoking intensity groups in Mexico. In addition, this dissertation examined the responses to pictorial HWLs across SES groups over time. This dissertation explored these relationships using large, population-based samples from Mexico. The ITC-Mexico data provides a unique opportunity to understand the smoking consumption patterns and explore the relationship between smoking consumption and smoke-free policies by following up smokers from the major cities of Mexico. The measures used in both the studies are rigorously tested, standardized and used extensively in tobacco control research. The short follow-up periods (i.e., every 4months) in the Warning Wearout data allowed for more nuanced examination of HWL response trajectories.

Chapter 3, examined the changes in cigarette consumption patterns for three groups of smokers: non-daily (ND), daily-light (DL), and daily-heavy (DH) smokers and the factors that were associated with these changes in cigarette consumption.

The results showed that compared to DH smokers, ND and DL Mexican smokers exhibited less stable smoking patterns. Among the three smoking groups at time t, ND smokers were more likely to achieve abstinence at the two follow-up periods, i.e., time t+1 and t+2. Quitting smoking and being stable were the two most common outcomes for the ND smokers rather than increasing cigarette consumption. About a quarter of initial ND smokers remained ND throughout the study period. Also, considerable proportion of baseline DL and DH smokers (i.e., 26% of initial DL smokers and 13% of initial DH smokers) reduced their consumption to ND status. DL smokers at time t were more likely to either increase their consumption to the DH level or to reduce to the ND level than to quit at t+1. However, once they converted to ND smokers at t+1, they were less likely to increase their consumption to DH levels at t+2 than to maintain at ND status. DH smokers at time t who cut down their smoking consumption to ND status may increase their future likelihood of quitting cessation. For all three smoking groups, perceived addiction was consistently an important factor associated with changes in cigarette consumption at successive follow-up. Only for a ND smoker, not having a smoking spouse/partner and the perception of what important people in their life think about their smoking was associated with changing cigarette consumption at the follow-up. For ND and DL smokers, quit attempts made in the past was statistical significantly associated with changing cigarette consumption at the follow-up; for DL and DH smokers, intending to quit in the next 6 months was associated with quitting/reducing consumption at the follow-up.

Overall, results from chapter 3 suggest that ND smoking is not a transient stage of smoking for the majority of Mexican smokers, and about a quarter of Mexicans continue to smoke ND throughout the study period. Reducing the number of cigarettes can be a stepping stone towards cessation for DH smokers. Smoking intensity and perceived addiction are the two important factors that are predictive of changes in cigarette consumption in future. Strengthening the social norms around smoking might promote cessation among ND smokers. Encouraging smokers to make quit attempts, even if unsuccessful and promoting intentions to quit can also help these smokers in achieving quit success in the future.

Chapter 4 examined the impact of the lack of SHS exposure at workplaces and hospitality industry venues in promoting cessation behavior and whether this relationship is either modified by the type of smoking ban (i,e., comprehensive or partial smoking ban) or by smoking intensity. Results of this study showed that lack of SHS exposure at workplaces was not associated with increased quit attempts and lack of SHS exposure at hospitality industry venues was also not associated with either increased quit attempts or quit success among a cohort of smokers in Mexico. Surprisingly, exposure to SHS at workplaces was associated with higher likelihood of quit success. The association between exposure to SHS at workplaces and hospitality venues and quit behaviors was not modified by the type of ban. Also, compared to daily-heavy smokers, smoke-free policies did not promote greater cessation among non-daily and daily-light smokers. Overall, these results indicated that only about a third of our study sample

were exposed to the smoke-free policy in the previous month and the compliance to policy at workplaces was not comparable to that of HICs (88, 209).

Chapter 5 examined HWL responses over time and assessed the socio-demographic and smoking-related differences in the responses to HWLs at baseline and over time. These results indicate that after two years of implementing pictorial HWLs in Mexico by rotating the content every six months, attention to HWLs declined over the study period while the cessation-related cognitive and behavioral responses to HWLs continued to increase over time. At baseline, compared to males, females were more likely to report attention to HWLs. However, there were no gender-differences in attention to HWLs over time. Also, there were no differences in cognitive and behavioral responses to HWLs at baseline or over time. At baseline, compared to smokers of younger age, smokers of middle age reported less attention to HWLs, stronger cognitive responses to HWLs and less frequent behavioral responses to HWLs. There were no age-related differences in any of the three HWL responses over time. There were no education-related differences in attention to HWLs at baseline or over time. Compared to low-educated smokers in our study, high educations smokers reported weaker cognitive responses to HWLs at baseline but no difference for slope. For behavioral response to HWLs, there were no education-related differences at baseline, but compared to low education smokers, high education smokers were less likely to report behavioral responses to HWLs over time. There were no income-related differences in attention to HWLs and cognitive responses to HWLs at baseline or over time. Compared to low-income smokers, high-income smokers reported less frequent behavioral

responses to HWLs at baseline but no differences in slope. Overall, these results indicate that the pictorial HWLs in Mexico are effective in promoting cessation-related responses and these responses to pictorial HWLs were not weaker among low SES smokers, and there is some indication that some of the HWL responses were stronger in low SES groups.

Study Limitations

Longitudinal Data

This dissertation used data from two population-based longitudinal datasets, ITC and wearout survey data. Attrition is the most common and challenging problem with longitudinal data that could pose a serious threat to internal validity of study results. The ITC data had follow-up rates that are in the acceptable range for longitudinal studies(234, 235): 73% follow-up from wave-III to IV, 83% follow-up from wave IV to V, and 79% follow-up from wave V to VI. Our analytic sample was more likely to be of older in age, female and to be less educated than the attrition sample. There were no statistical significant differences in smoking-related variables, i.e., smoking intensity, attempts to quit previously and intentions to quit in future, among the analytic and attrition samples. Previous studies using waves III to IV data showed that age and gender were not statistical significant predictors of the future quit status, but low education smokers were less likely to quit by the follow-up period (18). However, the results of this dissertation paper-I indicated that the follow-up smoking status for the socio-demographic characteristics was varied across the baseline smoking-status (results presented in appendix tables 5A, 5B and 5C). Younger ND smokers were likely

to increase their consumption at the follow-up, while younger DH smokers were more likely to quit by the follow-up period. Male DL smokers were more likely to increase their consumption while there were no gender differences in future smoking status for ND and DH smokers. There were no education-related differences in future quit status for ND and DL smokers but low-education among DH smokers was a predictor of being stable at the follow-up. Taken together, these results do not suggest a clear direction for any bias in our paper-I results that might be associated with this attrition.

In the Warning Wearout data, about 50% of the sample had only one wave of data. Compared to smokers with at least one wave of follow-up data, smokers who did not have any follow-up data were more likely to be of younger, less educated and of low income. However, the responses to HWLs and smoking-related variables were not different for smokers who had follow-up data in comparison to smokers who did not have follow-up data. This study used replenishment samples to maintain the sample size of 1,000 smokers. Also, the maximum likelihood estimation method used in the LGC models allowed us to use all possible waves of information from the smokers. Hence, the results of the correlates of HWL responses at baseline may not have been biased because of this loss to follow-up. But our ability to find any socio-demographics related differences in the slope parameters of HWL responses might have been limited because of this loss to follow-up.

Selection-bias

In the smoke-free policy evaluation study (paper-II), compared to the attrition sample, smokers from the analytic sample were less likely to have paid work indoors,

more likely to have visited a hospitality venue in the past month, and to have been exposed to SHS at hospitality industry venues, suggesting possible selection bias affecting the internal validity of this study. It is not clear whether this selection bias would lead to under- or over-estimation of study results.

The wearout study uses online consumer panel with no clearly defined sampling frame. The internet penetration in Mexico is only 37% according to 2013 estimates (233). Compared to the general Mexican population, the sample in this study has higher average income and education. However, smoking and socioeconomic status are generally unassociated in Mexico, so this is not as significant of a problem as it might be in countries where smoking is concentrated in low SES groups (236, 237). Also, other studies conducted among Mexican smokers show that compared to smokers with lower educational attainment, smokers with higher educational attainment have weaker responses to HWLs (221, 225). So, by having fewer low-education participants, this study might have been under-powered to detect greater responses to HWLs among the low-education groups. Also, because of fewer low-education participants, point estimates may have been underestimated.

Generalizability

The ITC-Mexico study was conducted in seven major cities of Mexico and rural areas were not included in this study. Hence the results from this study cannot be generalized to the entire population in Mexico. However, these seven cities represent the major areas of Mexico and about 78% of the Mexicans live in urban areas (207). Also, this study was conducted during the rapid implementation of FCTC recommended

tobacco control policies. Hence these results may not represent the cessation behavior of these smokers outside the policy environment. In the smoke-free policy evaluation study (paper-II), only about 30% of the smokers in our sample were either employed in indoor work or visited the hospitality venues in the past month. The results cannot be generalized to smokers who either do not work indoors or who have not been the hospitality venues in the past-month. The wearout study uses online consumer panel with no clearly defined sampling frame resulting in limited generalizability.

Self-reported Measures

Another important limitation of this dissertation is that all the measures used in this study were self-reported and might potentially be prone to social desirability bias that might result in overestimation of some measures such as social norms, quit attempts and responses to HWLs but underestimation of smoking intensity levels. The ITC surveys were face-to-face interviews and hence the responses might be more prone to social desirability bias compared to the Warning Wearout that used online survey tools to collect the responses anonymously. Hence the participants' responses in the Warning Wearout might be less prone to social desirability bias. However, one of the important measures of interest in this study is smoking intensity, and the proportion of low-intensity smokers in both ITC and wearout studies are in general consistent with those that have been found in other population-based surveys in Mexico(1, 5). The measures used in the ITC surveys and the Warning Wearout were rigorously tested and standardized (139). The measurement of exposure to SHS at workplaces and hospitality industry venues was based on participant's exposure to SHS in the previous month.

Hence, this measure may not capture the entire SHS exposure of the smoker at workplaces or hospitality industry venues. Also, smokers may under report their exposure to SHS if they do not feel comfortable reporting a violation. This could lead to information bias and underestimate the true impact of smoke-free policies. To address this issue, we used questions that ask smokers if 'anyone' had smoked instead of whether the participant had smoked.

Policy Implications and Future research

This dissertation offers some insight into how Mexicans' smoking consumption patterns are changing during the rapid implementation of FCTC-recommended tobacco control policies and the impact of pictorial HWLs across SES and smoking groups. The finding that smoking intensity and perceived addiction are important predictors of future smoking status has clinical significance. The light-intensity (i.e., ND and DL smokers) were less likely to be advised and offered cessation help by the physicians (18). Physicians can use a smoker's own perception of addiction as a guide to offer cessation help and refer them to cessation resources. The light-intensity smokers are less likely to be included in the smoking cessation interventions (196). There is little evidence about the effective strategies or interventions to help this group of smokers quit. The light-intensity smokers are less likely to identify themselves as smokers and may not recognize the health risks associated with even light-intensity smoking (50, 238). Cessation health messages should be targeted specifically towards light-intensity smokers and inform them of the health risks of smoking even at low levels. A recent study conducted in New York City suggested that hard hitting health messages targeting

specifically light-intensity smokers can increase their health knowledge and use of cessation services (239). Also, reducing the amount of smoking appears to help DH smokers in future quitting. So health messages should emphasize the benefits of cutting down the amount of smoking. ND Mexican smokers appear to be receptive to the social norms around smoking. Hence, implementing public health programs that further strengthen the social norms around smoking could help ND smokers to quit.

Though the primary goal of smoke-free policies is to reduce exposure to SHS, research from HICs suggests that the comprehensive smoke-free policies can promote smoking cessation (240). The compliance to smoke-free policies in Mexico is not comparable to that of HICs (88, 209). Therefore, the Mexican government should take additional actions to improve compliance to smoke-free polices. Also, an average of 70% of the Mexicans are not exposed to smoke-free policies at workplaces and hospitality industries. Hence, it is important to extend smoke-free policies to places where Mexicans are more likely to be exposed to SHS. Such policies in HICs are in general supported by both smokers and non-smokers(241). This expansion of smoke-free policies and strong implementation could further strengthen the anti-smoking social norms and promote smoking cessation. Research shows that smoke-free policies can promote higher cessation activity among light-intensity smokers (138). Given that more than two-thirds of Mexican smokers are light-intensity smokers (5), strongly implemented smoke-free policies could additionally benefit Mexico by reducing the smoking prevalence.

The evidence for effectiveness of pictorial HWLs across SES groups in LMICs is limited. Our findings suggest that implementation of pictorial HWLs with frequent rotation of content can help low SES groups to report similar cessation-related responses to HWLs. However, research is needed to understand whether pictorial HWLs are equally likely to promote smoking cessation across SES groups. Research is needed to increase our understanding about the pictorial HWL content that is most effective for low SES groups in a population-based setting. Other LMICs that have limited resources should consider pictorial HWLs as a priority and rotate the content frequently to prevent wearout of HWLs.

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APPENDIX A

Extended tables for paper-I

Table A. 1 : Association between socio-demographic factors and smoking status at the follow-up among baseline non-daily smokers

	Bivariate Association		Full Model	
	Quitter vs Stable	**Increase vs Stable**	**Quitter vs Stable**	**Increase vs Stable**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Age				
18 - 24	REF	REF	REF	REF
25 - 39	0.63 [0.370 - 1.060]	0.63 [0.379 - 1.043]	0.63 [0.378 - 1.065]	**0.62* [0.385 - 0.986]**
40 - 54	**0.59* [0.354 - 0.990]**	**0.58* [0.346 - 0.957]**	**0.58* [0.353 - 0.954]**	**0.51* [0.304 - 0.851]**
>54	1.85 [0.877 - 3.909]	1.43 [0.746 - 2.734]	1.25 [0.529 - 2.961]	0.92 [0.454 - 1.863]

	Bivariate Association		Full Model	
	Quitter vs Stable OR (95% CI)	**Increase vs Stable OR (95% CI)**	**Quitter vs Stable OR (95% CI)**	**Increase vs Stable OR (95% CI)**
Gender				
Male	REF	REF	REF	REF
Female	0.75	0.85	0.82	0.93
	[0.493 - 1.152]	[0.583 - 1.226]	[0.529 - 1.260]	[0.665 - 1.290]
Marital Status				
Married	REF	REF	REF	REF
Single	1.25	1.32	1.14	1.14
	[0.779 - 2.016]	[0.853 - 2.049]	[0.709 - 1.827]	[0.739 - 1.760]
Other	**2.31***	**2.23****	**2.19***	**2.04***
	[1.157 - 4.624]	**[1.316 - 3.782]**	**[1.027 - 4.688]**	**[1.148 - 3.608]**
Education				
Primary Education or less	REF	REF	REF	REF
Middle School	**0.59***	**0.62***	0.69	0.7
	[0.374 - 0.922]	**[0.419 - 0.920]**	[0.401 - 1.185]	[0.463 - 1.050]
Vocational school / HS / Incomplete University	**0.50***	**0.59***	0.63	0.59
	[0.292 - 0.870]	**[0.348 - 0.986]**	[0.341 - 1.152]	[0.338 - 1.014]
University & Postgraduate	0.9	0.83	1.11	0.72
	[0.436 - 1.868]	[0.447 - 1.525]	[0.505 - 2.462]	[0.370 - 1.403]
Income				
0 - 3,000	REF	REF	REF	REF
3,001 - 5,000	1.26	1.43	1.3	**1.62***
	[0.776 - 2.059]	[0.933 - 2.178]	[0.781 - 2.170]	**[1.057 - 2.490]**
5,001 - 8,000	0.82	1.58	0.83	**1.98****
	[0.476 - 1.416]	[0.999 - 2.483]	[0.444 - 1.539]	**[1.219 - 3.205]**

	Bivariate Association		Full Model	
	Quitter vs Stable	**Increase vs Stable**	**Quitter vs Stable**	**Increase vs Stable**
	OR	**OR**	**OR**	**OR**
	(95% CI)	**(95% CI)**	**(95% CI)**	**(95% CI)**
> 8,000	0.94	1.37	0.99	**1.67***
	[0.562 - 1.572]	[0.836 - 2.259]	[0.551 - 1.764]	**[1.014 - 2.762]**
Missing	1.18	1.45	1.16	1.65
	[0.491 - 2.818]	[0.612 - 3.457]	[0.485 - 2.763]	[0.694 - 3.936]
Wave				
3	REF	REF	REF	REF
4	0.77	1.06	0.82	**1.59***
	[0.500 - 1.198]	[0.726 - 1.562]	[0.526 - 1.270]	**[1.020 - 2.468]**
5	**0.60***	1.35	0.69	**3.16*****
	[0.383 - 0.925]	[0.910 - 1.992]	[0.395 - 1.219]	**[1.957 - 5.090]**
Time in Sample				
1	REF	REF	REF	REF
2	0.82	**0.52****	1.07	**0.36*****
	[0.520 - 1.280]	**[0.342 - 0.780]**	[0.635 - 1.789]	**[0.228 - 0.553]**
3	**0.42***	**0.27*****	0.67	**0.14*****
	[0.182 - 0.958]	**[0.151 - 0.499]**	[0.237 - 1.922]	**[0.075 - 0.266]**

*** p<0.001, ** p<0.01, * p<0.05

Table A. 2: Association between socio-demographic factors and smoking status at follow-up among baseline daily-light smokers

	Bivariate Association		Full Model	
	Quitter vs Stable	**Increase vs Stable**	**Quitter vs Stable**	**Increase vs Stable**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Age				
18 - 24	REF	REF	REF	REF
25 - 39	0.87	0.67	0.91	0.75
	[0.558 - 1.358]	[0.376 - 1.180]	[0.569 - 1.459]	[0.420 - 1.328]
40 - 54	0.87	1.03	0.93	1.29
	[0.520 - 1.452]	[0.558 - 1.895]	[0.546 - 1.598]	[0.652 - 2.569]
>54	0.95	0.75	0.95	0.88
	[0.583 - 1.533]	[0.405 - 1.384]	[0.550 - 1.627]	[0.453 - 1.712]
Gender				
Male	REF	REF	REF	REF
Female	0.74	**0.56****	0.8	**0.62***
	[0.531 - 1.028]	**[0.365 - 0.864]**	[0.560 - 1.151]	**[0.403 - 0.957]**
Marital Status				
Married	REF	REF	REF	REF
Single	1.17	1.28	1.09	1.41
	[0.794 - 1.735]	[0.831 - 1.986]	[0.727 - 1.629]	[0.863 - 2.317]
Other	0.88	0.71	0.87	0.74
	[0.544 - 1.426]	[0.357 - 1.395]	[0.543 - 1.398]	[0.353 - 1.530]

	Bivariate Association		Full Model	
	Quitter vs Stable	Increase vs Stable	Quitter vs Stable	Increase vs Stable
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Education				
Primary Education or less	REF	REF	REF	REF
Middle School	0.8 [0.519 - 1.220]	0.8 [0.480 - 1.328]	0.8 [0.522 - 1.238]	0.79 [0.461 - 1.344]
Vocational school / HS / Incomplete University	0.78 [0.532 - 1.137]	0.82 [0.490 - 1.365]	0.73 [0.484 - 1.105]	0.61 [0.341 - 1.107]
University & Postgraduate	1.65 [0.928 - 2.946]	1.04 [0.464 - 2.341]	1.55 [0.771 - 3.112]	0.72 [0.295 - 1.744]
Income				
0 - 3,000	REF	REF	REF	REF
3,001 - 5,000	1.03 [0.641 - 1.653]	**1.91* [1.079 - 3.375]**	1.08 [0.660 - 1.780]	**1.94* [1.059 - 3.537]**
5,001 - 8,000	0.97 [0.635 - 1.490]	**2.15** [1.217 - 3.802]**	0.95 [0.604 - 1.482]	**2.39** [1.282 - 4.442]**
> 8,000	1.23 [0.763 - 1.985]	**2.11* [1.105 - 4.031]**	1.02 [0.595 - 1.754]	**2.29* [1.128 - 4.651]**
Missing	1.07 [0.612 - 1.883]	1.64 [0.837 - 3.199]	0.99 [0.555 - 1.751]	1.9 [0.980 - 3.667]

	Bivariate Association		Full Model	
	Quitter vs Stable	**Increase vs Stable**	**Quitter vs Stable**	**Increase vs Stable**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Wave				
3	REF	REF	REF	REF
4	0.9	1.2	0.93	1.54
	[0.603 - 1.337]	[0.732 - 1.953]	[0.605 - 1.437]	[0.863 - 2.742]
5	**0.66***	1.11	0.8	**1.85***
	[0.452 - 0.951]	[0.747 - 1.664]	[0.517 - 1.244]	**[1.127 - 3.039]**
Time in Sample				
1	REF	REF	REF	REF
2	0.84	**0.54****	0.97	**0.44****
	[0.563 - 1.263]	**[0.353 - 0.828]**	[0.626 - 1.490]	**[0.268 - 0.732]**
3	**0.26*****	**0.20*****	**0.33****	**0.14*****
	[0.137 - 0.485]	**[0.079 - 0.504]**	**[0.163 - 0.675]**	**[0.051 - 0.367]**

*** p<0.001, ** p<0.01, * p<0.05

Table A. 3 : Association between socio-demographic factors and smoking status at follow-up among baseline daily-heavy smokers

	Bivariate Association	**Full Model**
	Quit or reduce vs Stable	**Quit or reduce vs Stable**
	OR (95% CI)	**OR (95% CI)**
Age		
18 - 24	REF	REF
25 - 39	0.75 [0.499 - 1.135]	**0.66* [0.449 - 0.966]**
40 - 54	**0.38*** [0.253 - 0.577]**	**0.36*** [0.239 - 0.535]**
>54	**0.44*** [0.285 - 0.674]**	**0.38*** [0.251 - 0.574]**
Gender		
Male	REF	REF
Female	1.26 [0.964 - 1.648]	1.3 [0.995 - 1.696]
Marital Status		
Married	REF	REF
Single	**1.45* [1.055 - 2.003]**	0.85 [0.580 - 1.245]
Other	**1.53* [1.023 - 2.296]**	**1.63* [1.046 - 2.544]**
Education		
Primary Education or less	REF	REF
Middle School	**1.54** [1.133 - 2.086]**	1.27 [0.918 - 1.763]
Vocational school / HS / Incomplete University	1.04 [0.709 - 1.518]	0.98 [0.650 - 1.483]
University & Postgraduate	**2.08** [1.249 - 3.463]**	**2.24** [1.262 - 3.962]**

	Bivariate Association	Full Model
	Quit or reduce vs Stable	**Quit or reduce vs Stable**
	OR (95% CI)	**OR (95% CI)**
Income		
0 - 3,000	REF	REF
3,001 - 5,000	1	0.94
	[0.691 - 1.443]	[0.646 - 1.376]
5,001 - 8,000	0.83	0.74
	[0.562 - 1.233]	[0.472 - 1.172]
> 8,000	1.04	0.81
	[0.694 - 1.548]	[0.533 - 1.236]
Missing	1.04	1.02
	[0.629 - 1.718]	[0.607 - 1.706]
Wave		
3	REF	REF
4	1.35	**1.69****
	[0.950 - 1.916]	**[1.172 - 2.436]**
5	1.16	**1.75***
	[0.809 - 1.658]	**[1.111 - 2.746]**
Time in Sample		
1	REF	REF
2	0.8	**0.64***
	[0.568 - 1.133]	**[0.452 - 0.903]**
3	**0.51****	**0.44****
	[0.319 - 0.826]	**[0.256 - 0.755]**

*** p<0.001, ** p<0.01, * p<0.05